277263

INSTRUCTION MANUAL

MODEL 162
30 MHz
FUNCTION GENERATOR

WAVETEK®

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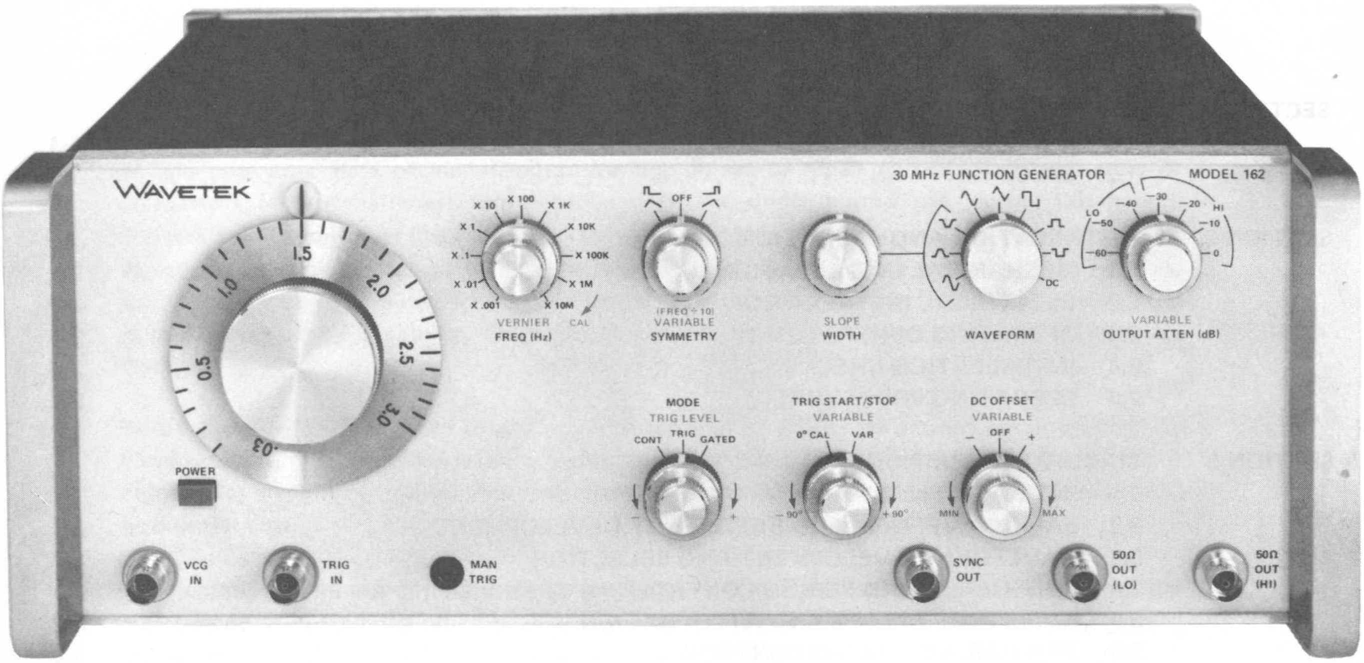


Figure i — Model 162 30 MHz Function Generator

SECTION 1
INTRODUCTION

1.1 PURPOSE OF THE EQUIPMENT

The Model 162 Function Generator offers an extended waveform versatility plus a frequency range that spans twelve decades, from 30 μHz (9.2 hours per cycle) to 30 MHz.

The waveforms available are sine, square, triangle, trapezoidal and positive and negative rectangular and trapezoidal pulse, each with variable amplitude, dc offset and symmetry.

The trapezoidal waveform rise and fall times may be varied by means of independent slope, width and symmetry controls. Different rise times and fall times, both controllable, may be selected to suit your testing or triggering requirements.

The Model 162 can be triggered, gated, or swept by an external signal.

1.2 SPECIFICATIONS

1.2.1 Waveforms

Eight selectable waveforms, sine , triangle , square , positive pulse , negative pulse , trapezoid , positive trapezoid , and negative trapezoid , plus variable DC output. Symmetry of all waveform outputs is continuously adjustable from 1:19 to 19:1. Varying symmetry provides variable duty-cycle pulses, sawtooth or unsymmetrical trapezoidal waveforms. Separate sync output included.

1.2.2 Operating Frequency Range

Frequency selectable from 0.00003 Hz to 30 MHz in the following ranges.

X 0.001	0.00003 Hz to 0.003 Hz
X 0.01	0.0003 Hz to 0.03 Hz
X 0.1	0.003 Hz to 0.3 Hz
X 1	0.03 Hz to 3 Hz
X 10	0.3 Hz to 30 Hz
X 100	0.3 Hz to 300 Hz
X 1K	3 Hz to 3 kHz
X 10K	30 Hz to 30 kHz
X 100K	300 Hz to 300 kHz
X 1 MHz	3 kHz to 3 MHz
X 10 MHz	30 kHz to 30 MHz

NOTE

When SYMMETRY control is used, indicated frequency is divided by a factor of approximately 10.

1.2.3 Outputs

Main Output

Maximum output of sine, triangle, square and trapezoidal waveforms is 20 V p-p into open circuit and 10 V p-p into 50Ω load. Positive and negative trapezoids and pulses are 10 V peak into open circuit and 5 V peak into 50Ω. DC voltage is adjustable between ±10 volts, 50Ω source impedance. Output peak current is 130 mA minimum for all waveforms and DC. Precision output allows from 0 dB to −60 dB attenuation in 10 dB steps with a 20 dB vernier; maximum overall attenuation is −80 dB. High level 0 to −50 dB and low level −40 to −80 dB outputs give optimum performance.

Sync Output

Approximately 0 to +4 V into open circuit, 50Ω source impedance. Rise and fall times are typically 10 ns into 50Ω load. Sync is a square waveform during symmetrical outputs, rectangular waveform when SYMMETRY control is ON.

1.2.4 DC Offset

Front panel controlled between ±10 Vdc into open circuit, ±5 Vdc into 50Ω load. Peak voltage output (signal peak plus dc offset) is limited to ±10 V into open circuit, ±5 V into 50Ω load. DC offset and output waveform are attenuated proportionately by the attenuator.

1.2.5 Main Generator Operational Modes

Continuous

Operating as a standard VCG (voltage controlled generator), frequency output is determined by front panel control

settings in conjunction with external control voltage at VCG IN.

Triggered
Only one complete cycle of output appears at 50Ω OUT connector for each pulse applied to TRIG IN connector (or press of MAN TRIG switch).

Gated
Same as triggered mode except that output oscillations continue for duration of gating signal applied to TRIG IN connector.

1.2.6 Voltage Controlled Generator

VCG Control Range
Up to 1000:1 frequency change with external voltage input. Upper frequency is limited to maximum of selected range. Required external signal for full voltage control is 0 to 5 V with input impedance of 5 kΩ.

VCG Slew Rate
2% of range per μs.

VCG Linearity
0.0003 Hz to 3 MHz . . . . ±0.5% of range

1.2.7 Triggered Generator

Trigger Input
Trigger pulse is 1 V p-p to ±50 V; input impedance is 10 kΩ, 33 pF; minimum pulse width is 25 ns; maximum repetition rate is 20 MHz.

Start/Stop Point Adjustment
Triggered-signal start/stop point is adjustable:
To 3 MHz . . . . . . Approximately -90° to $+90^\circ$
3 MHz to 30 MHz . . . . Approximately -90° to 0°

1.2.8 Horizontal Precision

Dial Accuracy for Symmetrical Waveforms*
0.0003 Hz to 300 kHz . ±(1% of setting +1% of full scale)
300 kHz to 30 MHz . . ±(3% of setting +2% of full scale)

Frequency Vernier
Electronic frequency vernier precision frequency adjustment is approximately 1% of range.

Time Symmetry*
0.0003 Hz to 30 Hz . . . . ±1.0%
30 Hz to 300 kHz . . . . ±0.5%

1.2.9 Vertical Precision

Amplitude Change with Frequency (Sine)
Less than:
0.1 dB to 300 kHz
0.2 dB to 3 MHz
2.5 dB to 30 MHz

Step Attenuator Accuracy
±0.25 dB per 10 dB step.

Stability*
Short term . . . . ±0.05% for 10 minutes
Long term . . . . ±0.25% for 24 hours
Percentages apply to amplitude, frequency, and dc offset.

Amplitude Symmetry
All symmetrical waveforms are symmetrical about ground within ±1% of amplitude range up to 3 MHz (e.g. within ±100 mV with output attenuator at 0 dB).

1.2.10 Purity*

Sine Wave Distortion
10 Hz to 100 kHz . . Less than 0.5% (typically 0.25%)
0.0003 Hz to 3 MHz . . . . Less than 1.0%
3 MHz to 30 MHz . All harmonics at least 26 dB down

Triangle Linearity
0.0003 Hz to 300 kHz . . . . . . Greater than 99%

Square Wave Rise and Fall Time
Less than 12 ns (typically 8 ns) when terminated into 50Ω load.

Square Wave Total Aberrations
Less than 5%.

Trapezoidal Rise and Fall Time
Ratio of period to rise or fall time is continuously variable from 2:1 (triangle) to greater than 100:1 and limited to 12 ns (maximum) rise and fall time.

1.2.11 Environmental

Temperature
All specifications listed are for 25°C ±5°C. For operation from 0°C to 55°C, specifications including horizontal precision, amplitude symmetry, and sine wave distortion are derated by a factor of 2.

1.2.12 Mechanical

Dimensions
14½ in./36.8 cm wide; 5¼ in./13.3 cm high; 13½ in./34.3 cm deep.

Weight
12 lb/5.5 kg net; 19 lb/8.6 kg shipping.

Power
90 to 110 V, 105 to 125 V, 180 to 220 V or 210 to 250 V; 50 to 400 Hz; less than 50 watts.

NOTE

Specifications apply from 10 to 100% of a selected frequency range.

*SYMMETRY control OFF.

SECTION 2

INSTALLATION AND OPERATION

2.1 MECHANICAL INSTALLATION

After unpacking the instrument, visually inspect all external parts for possible damage to knobs, connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packing material should be saved in case reshipment is required.

2.2 ELECTRICAL INSTALLATION

2.2.1 Power Connection

Connect the ac line cord to the mating connector at the rear of the unit.

NOTE

Unless otherwise specified at the time of purchase, this instrument was shipped from the factory with the power transformer connected for operation on a 105 - 125 Vac line supply and with a 1/2 amp line fuse.

Conversion for 90 to 110 V, 180 to 220 V or 210 to 250 V operation requires resetting two switches on the inside of the rear panel. To reset the switches, unscrew the four captive screws securing the rear panel, and remove the rear panel. Set the two switches and select the fuse for the ac line voltage according to the following table.

AC Line Voltage	Switch A	Switch B	Fuse (SB)
90 - 110	115	LO	½ amp
105 - 125	115	HI	½ amp
180 - 220	230	LO	¼ amp
210 - 250	230	HI	¼ amp

2.2.2 Signal Connections

Use 50Ω shielded cables equipped with female BNC connectors to distribute all signals when connecting this instrument to associated equipment.

The two main outputs, 50Ω OUT (LO) and 50Ω OUT (HI), should be terminated with 50Ω load when used for optimum performance.

2.3 OPERATING CONTROLS

The operating controls and electrical connections for the Model 162 are shown in Figure 2-1. The listing below discusses each control and its function.

1. **POWER Switch** – Power is on when this pushbutton switch is in, and off when extended.

2. **Frequency Index** – The scribe line indicates the frequency dial setting. The index is illuminated when the unit is on.

3. **Frequency Dial** – The main frequency control. The setting on this dial multiplied by the frequency range setting is the basic output frequency of the generator. (The FREQ (Hz) VERNIER, the SYMMETRY control and VCG IN also affect the generator frequency.)

4. **FREQ (Hz) Range** – This 11 position switch selects the generator frequency range, which, when multiplied by the frequency dial setting, determines the basic output frequency of the generator.

5. **FREQ (Hz) VERNIER Control** – This control allows precision control over the output frequency. A complete turn of this vernier is equivalent to approximately one half of the smallest division on the main frequency dial. When in the full clockwise position (CAL), the settings on the main dial will be accurate.

6. **SYMMETRY Control** – The large knob selects a right-hand or left-hand waveform time-symmetry. The small VARIABLE knob varies the waveform time-symmetry up to 19:1 or 1:19. When these controls are used, the frequency range is divided by approximately 10.

   The duty cycle of the square wave can be varied from , to ; the slope of the triangle from , to ; and the rise to fall time ratio of the trapezoid from , to . See

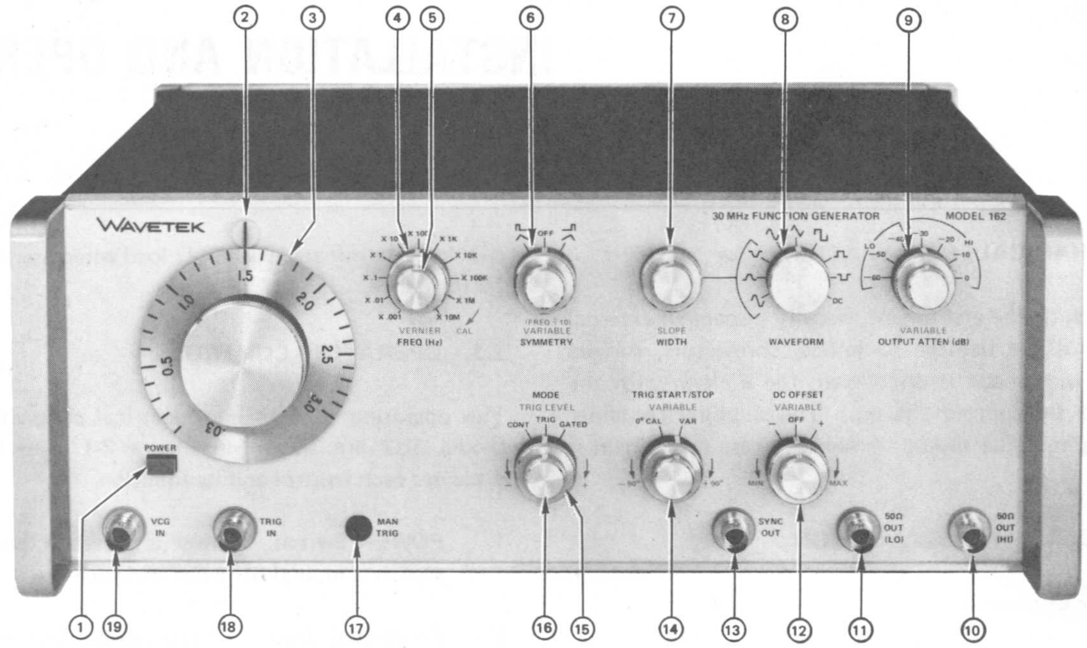


Figure 2-1. Operating Controls and Electrical Connections, Front Panel

Figure 2-2 for the sync signal relationship.

7. **SLOPE/WIDTH Control** – The small knob controls the slope of the trapezoidal waveforms. The large knob controls the time symmetry of the waveform. The setting of these controls does not affect the other waveforms. See Figure 2-2 for the sync signal relationship.

8. **WAVEFORM Selector** – This control selects the waveform that appears at the 50Ω output connector. The waveforms are sine , triangle , square , positive going rectangular pulse , negative going rectangular pulse , trapezoidal , positive going trapezoidal pulse , negative going trapezoidal pulse , and DC voltage.

9. **OUTPUT ATTEN (dB) Control** – The large knob attenuates the 50Ω output from 0 dB (10 V p-p max into 50Ω load) to –60 dB (10 mV p-p into 50Ω) in 10 dB steps. LO and HI indicate the correct output connector to use. The small VARIABLE knob may be used to continuously change the amplitude by approximately 20 dB. Maximum attenuation is –80 dB (1.0 mV p-p into 50Ω). The OUTPUT ATTEN (dB) VARIABLE control is inoperative when DC is selected on the WAVEFORM selector.

10. **50Ω OUT (HI)** – This is the selected waveform

NOTE: VARIABLE SYMMETRY OFF

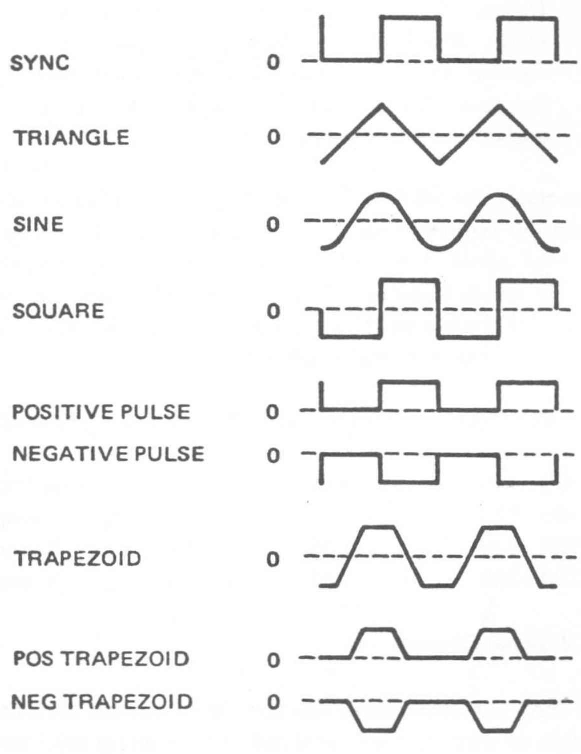


Figure 2-2. Selectable Waveforms and Sync Signal Phase and Polarity Relationships

output for the main generator or a dc voltage when the OUTPUT ATTEN (dB) switch is set 0 to −30 dB. The Model 162 operating into an open circuit provides 20 V p-p maximum, or into a 50Ω load provides a 10 V p-p output for the sine, triangle, square and trapezoidal waveforms; maximum trapezoidal and rectangular pulses are 10 V into an open circuit and 5 V into a 50Ω load.

11. **50Ω OUT (LO)** – This is the selected waveform output for the main generator or a dc voltage when the OUTPUT ATTEN (dB) control is set −40 dB to −60 dB.

12. **DC OFFSET Control** – Adjusts dc base line offset above (+) or below (−) signal ground; or, when DC is selected on the WAVEFORM selector, adjusts dc voltage at the 50Ω output. The large knob selects polarity, and the small VARIABLE knob adjusts voltage up to ±10 Vdc into an open circuit (±5 Vdc into 50Ω load).

    Peak signal output (waveform plus dc offset) is limited to ±10 Vdc into an open circuit (±5 Vdc into a 50Ω load). (The OUTPUT ATTEN (dB) control affects dc offset as well as waveform amplitude.)

13. **SYNC OUT** – This is a square wave (or rectangular if SYMMETRY control is in use) with the same frequency and same polarity of the selectable square wave at a 50Ω output. Amplitude into an open circuit is greater than 4 V p-p (2 V p-p into 50Ω). See Figure 2-2.

14. **TRIG START/STOP Control** – The large knob switched to VAR allows the triggered output signal start and stop point to be varied by turning the small knob. For sine and triangle waveforms, the start/stop point may be varied from negative peak voltage to almost positive peak voltage. (At the higher frequencies, the limits are negative peak to waveform zero level.) The square wave always starts/stops at negative peak voltage. The rectangle pulses always start/stop at waveform zero level. The trapezoidal waveform start/stop points are continuously variable. When the large knob is set to 0° CAL, sine and triangle waveforms start/stop at waveform zero level; square and positive rectangular pulse waveforms start/stop at negative peak level; trapezoidal and trapezoidal pulse waveform start/stop points vary with the SLOPE/WIDTH control settings.

15. **GEN MODE Switch** – Selects the operating mode of the main generator (50Ω OUT) as follows:

    a. CONT Mode – The generator operates continuously as a standard Voltage Controlled Generator (VCG). Frequency output is determined by front panel control settings in conjunction with external control voltage at VCG IN.

    b. TRIG Mode – The generator will give one complete cycle of output when the MAN TRIG is pressed or for each cycle of signal applied to TRIG IN. The generator output cycle begins and ends as determined by the TRIG START/STOP control.

    c. GATED Mode – Operates the same as TRIG mode except that the generator will continue to have output for the full time that the MAN TRIG switch is held down or the gate signal at TRIG IN exceeds the gating level set by the TRIG LEVEL control.

16. **TRIG LEVEL Control** – A continuously variable adjustment of the TRIG IN circuitry. When full ccw, approximately a positive going pulse of +7.5 V (A, Figure 2-3) or greater voltage is required for triggering. In the full cw position, a positive going pulse of approximately −7.5 V (B, Figure 2-3) or more positive voltage is required for triggering. In the GATED mode, the generator will begin to run continuously at some position of the control cw past 12 o'clock. When using the MAN TRIG, this control must be ccw of the midpoint.

17. **MAN TRIG Switch** – When in TRIG mode, pressing this switch furnishes the trigger. When in GATE mode, this switch furnishes the gate signal for the duration that it is pressed and held down. The TRIG LEVEL control must be ccw from midpoint for proper MAN TRIG operation.

18. **TRIG IN** – A dc coupled input with 10 kΩ, 33 pF input impedance. The TRIG LEVEL control adjusts the sensitivity of the generator to this input signal. Trigger signals must be 1 V p-p or greater but within the range of ±50 V. Trigger signal width must be 25 ns or greater. Trigger frequency must be less than 20 MHz.

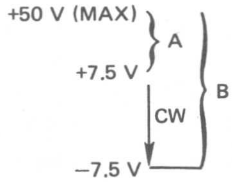


Figure 2-3. Range of Triggering Voltage

19. **VCG IN** – This connector allows external control of frequency. With 0 volt in, the basic generator frequency (50Ω OUT) is determined by the frequency range selected and the frequency dial setting. A positive VCG voltage will increase this frequency, and a negative voltage will decrease the frequency. Input impedance is 5 kΩ. Restrictions for linear operation are (1) the upper frequency limit is the value selected with the FREQ (Hz) switch, (2) the lower frequency limit is one-thousandth the value selected with the FREQ (Hz) switch. A 5-volt excursion covers the 1000: 1 frequency range.

2.4 INSTALLATION CHECKS

The following procedures are used to determine that the instrument is operating properly. Field calibration and check-out instructions (to be supplied) are to be used to ensure that the instrument complies with the specifications. If the instrument is not operating properly or within specifications, refer to the warranty on the back of the title page.

Use a Tektronix Model 454 oscilloscope (or equivalent) and a Counter-Timer when performing these installation checks.

1. After connecting the line cord to the ac line, set the front panel controls and switches as follows:

POWER	In
Frequency Dial	1.0
FREQ (Hz) Range	X 1K
FREQ (Hz) VERNIER	Fully Clockwise
SYMMETRY	OFF
WAVEFORM	
OUTPUT ATTEN (dB)	0
OUTPUT ATTEN (dB) VARIABLE	Fully Clockwise
DC OFFSET	OFF
TRIG START/STOP	0° CAL
GEN MODE	CONT

2. Connect the 50Ω OUT (HI) connector with a shielded cable terminated in a 50 ohm load to the oscilloscope and set FREQ (Hz) VERNIER to obtain 1 kHz display on the oscilloscope. Approximately 10 V p-p should be displayed.

3. Rotate OUTPUT ATTEN (dB) VARIABLE control full ccw. Increasing signal attenuation should be observed. Return to full cw.

4. Set SLOPE control (small knob) full cw and WIDTH control (large knob) at approximately midpoint.

5. Check amplitudes of sine , triangle and trapezoidal waveforms. They should be approximately 10 V p-p.

6. Use SLOPE/WIDTH control to vary the slope and time symmetry of the trapezoidal waveform.

7. Check minimum and maximum amplitudes of positive and negative pulse waveforms, both rectangular and trapezoidal. Amplitudes should be approximately 5 volts above or below the 0 volt level.

8. Switch the FREQ (Hz) range control to check range-to-range tracking accuracy. The oscilloscope should show approximately the FREQ (Hz) range value.

9. Select the square waveform and rotate the SYMMETRY switch to and the VARIABLE control full cw. Waveform asymmetry should be approximately 19:1. Rotate the VARIABLE control full ccw; the waveform should be symmetrical. Verify that the other switch position and VARIABLE control give approximately 1:19 waveform asymmetry.

10. Turn the SYMMETRY switch to OFF and select DC on the WAVEFORM selector. Use a shielded cable with BNC connectors to connect SYNC OUT to the oscilloscope trigger input.

11. Set the DC OFFSET switch to + and rotate the VARIABLE control full cw. The amplitude should be approximately +5 V into a 50Ω load.

12. Set the DC OFFSET switch to –. Amplitude should be approximately –5 V.

13. Rotate the OUTPUT ATTEN (dB) switch thru each position. Verify the attenuation on the oscilloscope. (The VARIABLE control is inoperative for DC.) Repeat using 50Ω OUT (LO) connector.

14. Reset the OUTPUT ATTEN (dB) switch to 0 and VARIABLE control to full cw. Select with the WAVEFORM selector.

15. Set the GEN MODE switch to GATED and rotate the TRIG LEVEL control while observing the oscilloscope. The multiple cycles of the selected output waveform should appear when the TRIG LEVEL control is rotated cw. Reset to full ccw.

16. Use MAN TRIG switch to gate waveforms. Waveforms should be continuous when MAN TRIG switch is held down.

17. Set the GEN MODE switch to TRIG. Use MAN TRIG switch to trigger waveforms. One cycle should appear each time the trigger is pressed.

18. Set TRIG START/STOP switch to VAR. Trigger the generator while rotating the TRIG START/STOP VARIABLE control to various positions. The waveform start/stop points should change.

2.5 OPERATING PROCEDURE

No preparation for operation is required beyond completion of the initial installation checks given in Paragraph 2.4 of this manual. It is recommended that a one-half hour warm-up period be allowed for the associated equipment to reach a stabilized operating temperature, and for the Model 162 to attain stated accuracies.

There are almost unlimited ways to set up the generator and waveforms that may be obtained. The following sections describe basic configurations and how to set them up.

2.5.1 Operation as a Function Generator

1. Depress the POWER switch. Properly terminate the 50Ω OUT (HI) connector.

2. Set the GEN MODE switch to CONT.

3. Set the FREQ (Hz) range switch to the desired multiplier.

4. Set the frequency dial to the desired setting. Use the frequency VERNIER for precision frequency setting if necessary.

5. Select desired basic output waveform using the WAVEFORM selector.

6. Set OUTPUT ATTEN (dB) switch for desired output level and amplitude. If a LO amplitude signal is selected, use the 50Ω OUT (LO) connector.

For reference, the following table gives the approximate output amplitude levels at attenuator settings. The output levels of the positive and negative pulse waveforms are one-half of these levels.

TABLE 2-1

Attenuator Position	Peak-to-Peak Output into 50Ω Load	
	Maximum (variable full cw)	Minimum (variable full ccw)
0 dB	10 V	1 V
−10 dB	3.2 V	320 mV
−20 dB	1 V	100 mV
−30 dB	320 mV	32 mV
−40 dB	100 mV	10 mV
−50 dB	32 mV	3.2 mV
−60 dB	10 mV	1 mV

7. Set the SYMMETRY control for desired asymmetry. The SYMMETRY control is used to develop ramp waveforms from the triangle, to vary the duty cycle of the square wave, to vary the ratio of rise/fall time of the trapezoidal waveform. Figure 2-4 shows the effect of this control on output waveforms. The output frequency is divided by approximately a factor of 10 when an asymmetrical waveform is selected.

8. When the trapezoidal waveform is selected, the WIDTH control is used to vary the duty cycle of the waveform and the SLOPE control is used to vary both rise and fall times. See Figure 2-5. Use the SYMMETRY control if asymmetrical rise and fall times are desired. See Figure 2-4.

9. Select the desired polarity of dc offset and the amount of offset using the DC OFFSET control. Offset voltage plus peak voltage cannot exceed the voltage range limit, ±5 volts in the 0 dB range. If an excessive amount of dc offset is used, waveform clipping may be observed (see Figure 2-6). Both signal and offset are attenuated by the attenuator.

2.5.2 Operation as a Voltage Controlled Generator

The VCG input connector can be used to externally control the frequency of the generator. If a positive voltage is applied to the VCG input terminal, the frequency will increase from the setting of the frequency controls. A negative voltage will cause the frequency to decrease from the setting of the frequency controls.

A 5 V excursion in VCG voltage can vary the frequency up to 1000:1 in each range as follows:

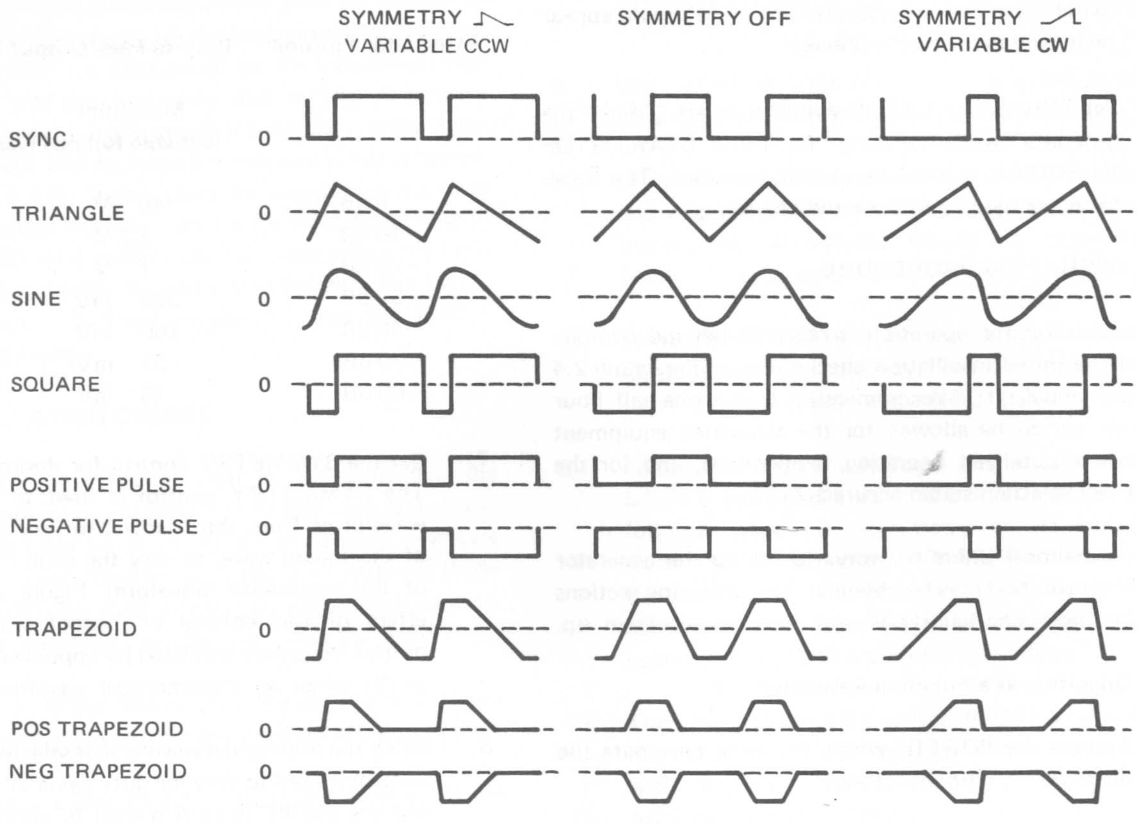


Figure 2-4. Effect of Symmetry Adjustment on Waveforms

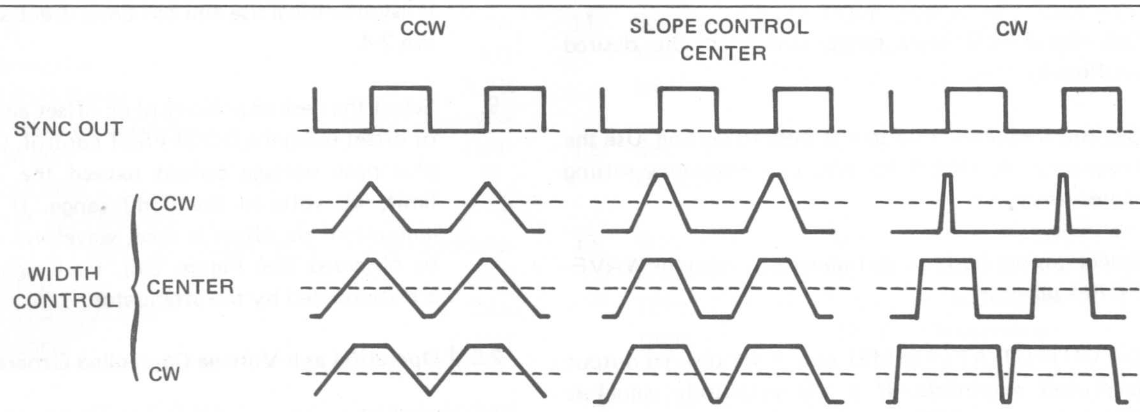


Figure 2-5. Effect of SLOPE/WIDTH Control on the Trapezoid Waveform

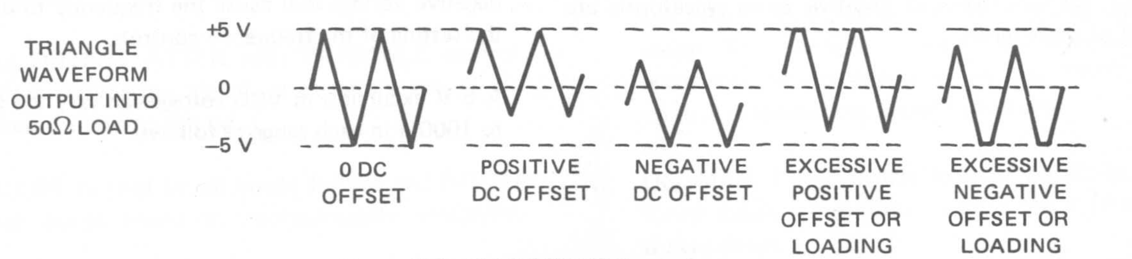


Figure 2-6. DC OFFSET Control

Range	Limits for Linear Operation	
	Lower	Upper
X0.001	0.003 mHz	0.003 Hz
X0.01	0.03 mHz	0.03 Hz
X0.1	0.3 mHz	0.3 Hz
X1	3 mHz	3 Hz
X10	30 mHz	30 Hz
X100	300 mHz	300 Hz
X1K	3 Hz	3 kHz
X10K	30 Hz	30 kHz
X100K	300 Hz	300 kHz
X1M	3 kHz	3 MHz
X10M	30 kHz	30 MHz

The upper limit may be exceeded as there is an overranging capability; however, overranging will be nonlinear and the operation is unspecified. Operation below the lower limit of any range setting is not recommended.

The nomograph of Figure 2-7 shows the characteristics of the VCG circuit. Column A gives the frequency dial setting, column B, the VCG voltage and column C, a factor representing the resultant frequency of the generator.

In example 1, the dial is set at 1.5 and no VCG input is applied. Extend a straight line from 1.5 (dial setting) thru 0 volt (VCG voltage). The result is an output frequency factor of 1.5. Multiply 1.5 by the range multiplier for actual 50Ω OUT frequency.

In order to set the generator at 0.003 X the range multiplier (1/1000 of the range), the following procedure is to be followed (Example 2):

1. Using the frequency dial and a counter or oscilloscope, set the generator frequency to 0.03 X the range multiplier.
2. By rotating the VERNIER ccw, decrease the frequency to 0.003 X the range multiplier.

As can be seen from the nomograph a +5 volt VCG input will then cause the frequency to increase to the maximum of 3 X the range (an increase from 0.003 X to 3 X is 1:1000).

2.5.3 Operation as a Triggered Generator

1. Adjust the generator as for continuous operation (Paragraph 2.5.1); then set the GEN MODE switch to TRIG.
2. For external triggering, apply a repetitive signal, any waveform from 1 V p-p to less than ±50 V peak voltage (see TRIG IN specification, Paragraph 2.3, Item 18), to TRIG IN connector. Set the TRIG LEVEL control for proper triggering. See Figure 2-8 for the timing relationship of the trigger input, sync output and selected waveform output.
3. If manual triggering is desired, set the TRIG LEVEL control full ccw and operate the MAN TRIG switch for each cycle of selected output waveform.

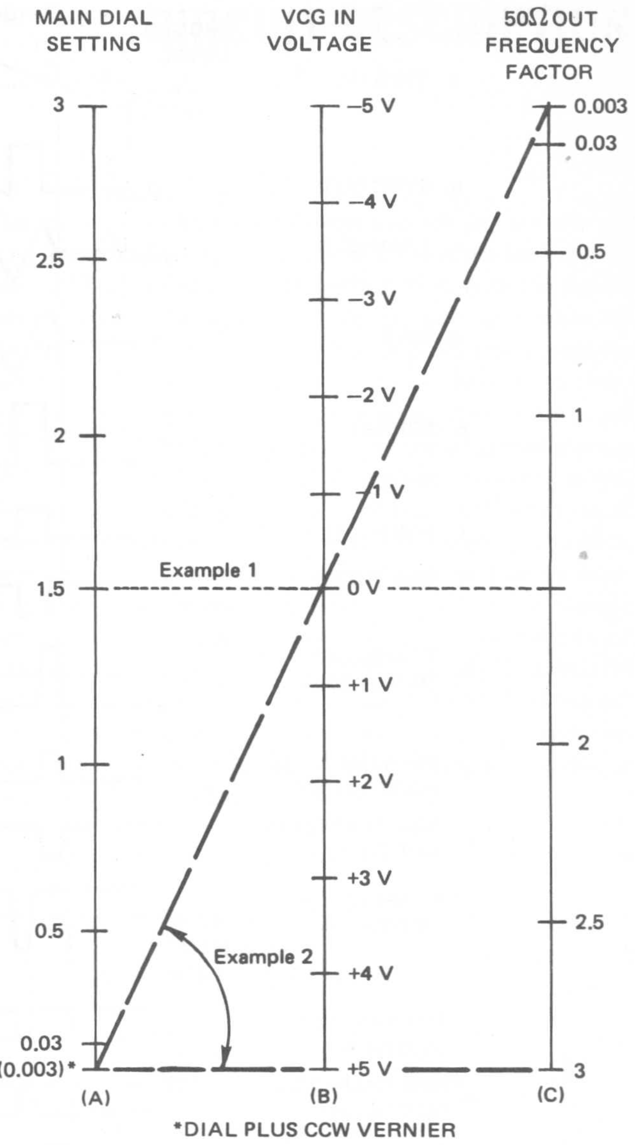


Figure 2-7. VCG Voltage-to-Frequency Nomograph

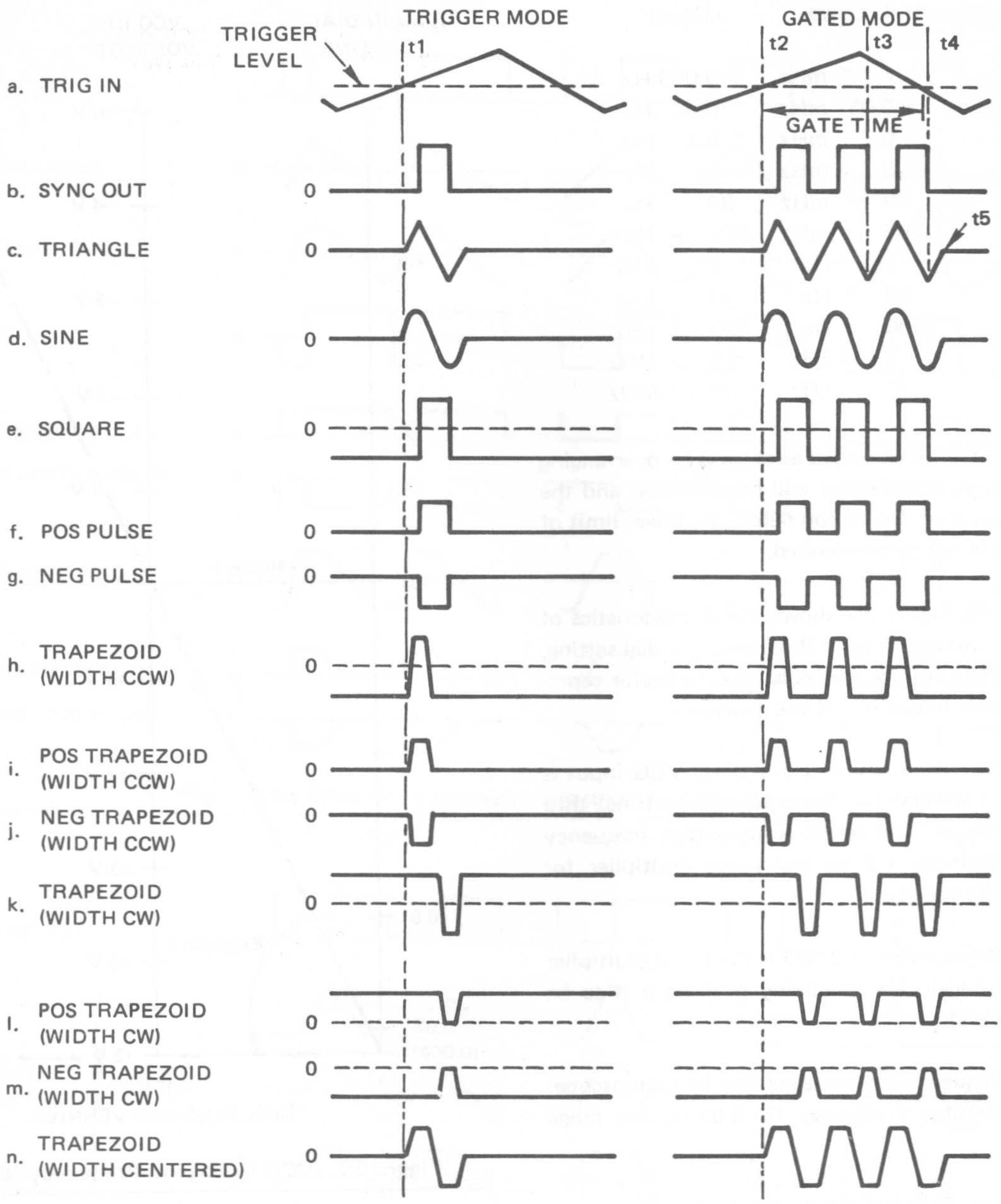


Figure 2-8. Trigger and Gated Operations

2.5.4 Gated or Tone Burst Operation

With the generator adjusted as in trigger operation, change the GEN MODE control to GATED position. The generator output will then be a burst of cycles. If the trigger is a waveform such as a sawtooth, the duration of the burst is adjustable by the TRIG LEVEL control (see Figure 2-8). Notice that the last cycle gated is completed at time t5, if the gate signal is removed between time t3 and t4. In manual gating, set TRIG LEVEL control full ccw. The tone burst continues as long as the manual switch is pressed.

The generator can be made to free run in this mode at certain settings of the trigger level control. By resetting the trigger level control, normal gated operation can be re-established.

SECTION 3
CIRCUIT DESCRIPTION

3.1 INTRODUCTION

This section provides a circuit description of the Model 162 generator for the understanding of its principles of operation. The paragraphs are grouped under six major categories. These categories are arranged in the sequence of first understanding the heart of the generator, and then examining the circuits that influence it and the circuits that it in turn influences.

The major circuit blocks that make up the generator are introduced in all capital letters. These blocks relate to the functional block diagrams of the main circuit board shown in Figure 3-3 at the back of this section. The circuit blocks are also identified on the appropriate schematic diagrams in Section 6.

3.2 BASIC WAVEFORM AND FREQUENCY DEVELOPMENT

The heart of the generator is a triangle and square wave generator. The triangle waves are developed by capacitor-charging ramps that are alternately reversed in polarity. The polarity reversal is caused by a flip-flop circuit that in turn produces the square waves. The flip-flop, or HYSTERESIS SWITCH changes states upon detecting amplitude limits of the charging ramps thru TRIANGLE AMPLIFIER NO. 1.

3.3 WAVEFORM DEVELOPMENT AND SELECTION

The WAVEFORM SELECTOR switch determines which of eight waveforms is to be output from the generator. A dc level can also be selected for output.

The triangle wave from triangle amplifier No. 1 is coupled thru unity gain TRIANGLE AMPLIFIER NO. 2 and made available to the waveform selector switch. Triangle amplifier No. 2 compensates for the output of amplifier No. 1 not having a low enough impedance to drive several other circuits. Triangle amplifier No. 2 provides the inputs for developing the sine and trapezoid waves. The SINE CONVERTER converts the triangle wave into a sine wave and makes it available to the waveform selector switch.

The square wave from the hysteresis switch and the triangle wave from triangle amplifier No. 2 are selected for input to the SQUARE & TRAPEZOID AMPLIFIER. With the square wave as input, the amplifier develops the square wave for output, as well as positive rectangular pulse and a negative rectangular pulse. The rectangular pulses result from rectifying either polarity of the square wave. With the triangle wave as input, the amplifier develops the trapezoid wave, a positive trapezoid pulse, and a negative trapezoid pulse. Similar to the rectangular pulses, the trapezoid pulses result from rectifying the trapezoid wave. The trapezoid wave is developed by a controlled overdriving of the triangle wave amplitude, the positive and negative peaks of the triangle being clipped. The SLOPE control determines the gain of triangle amplitude overdriving (see Figure 3-1). The WIDTH control determines the offset of the "amplitude window" between the clipped peaks (see Figure 3-2). The waveforms from the square & trapezoid amplifier are made available to the waveform selector switch.

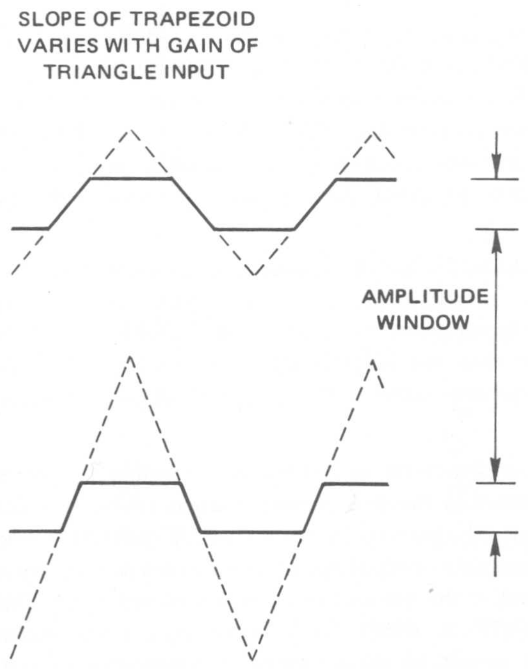


Figure 3-1. Trapezoid Slope Control

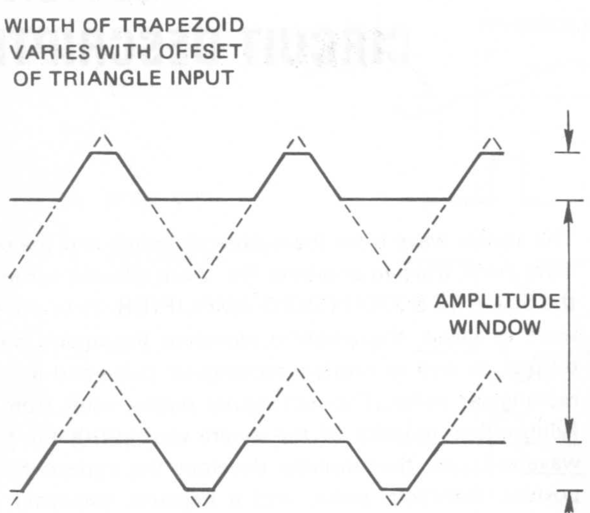


Figure 3-2. Trapezoid Width Control

The square wave from the hysteresis switch thru the SYNC AMPLIFIER is externally available at the SYNC OUT connector. The sync pulse, then, is a constant amplitude, square wave output of the generator's frequency and time symmetry.

3.4 FREQUENCY AND PERIOD CONTROL

The frequency of the waveforms is determined by selecting particular TIMING CAPACITORS to develop the triangle wave charging ramps. For slower charging times, and thus lower frequencies, a CAPACITANCE MULTIPLIER is used. The capacitance multiplier absorbs precise amounts of charging current, thereby slowing down the charging times.

The DIODE GATE supplies the appropriate polarity of charging current to the timing capacitors. Current is alternately switched from the POSITIVE CURRENT GENERATOR and then the NEGATIVE CURRENT GENERATOR with each alternation of the hysteresis switch square wave.

Waveform time symmetry is controlled by increasing or decreasing the two current sources relative to each other. Unequal charging currents thereby generate triangle wave ramps with unequal slopes. The current sources are normally equal in the amount of current supplied. The SYMMETRY CONTROL AMPLIFIER, however, can be switched into the circuit to allow setting an unbalance of the current sources' reference voltages. When this asymmetry is selected, frequency is divided by ten due to the supply limits of the current generators.

The input control voltage to the symmetry control amplifier and both current generators is provided by the VCG AMPLIFIER. Voltages from the FREQUENCY DIAL, the FREQUENCY VERNIER, and the VCG IN connector are summed together to determine the frequency control voltage from the VCG amplifier. The control voltage thru the GCV AMPLIFIER is externally available at the GCV OUT connector.

3.5 AMPLITUDE OFFSET AND ATTENUATION

The selected waveform is inverted and approximately doubled thru the PREAMPLIFIER. The VARIABLE output attenuator control provides up to 20 dB of attenuation of the waveform at the generator's output. Positive or negative reference level offset can be selected by the DC OFFSET control. The VARIABLE dc offset control provides the actual amount of offset to the selected waveforms center reference.

The preamplifier waveform is again amplified by the OUTPUT AMPLIFIER. The output amplifier is also an inverting amplifier, only with a current limiting output stage for short circuit protection. The output amplifier establishes the generator's 0 dB attenuation reference. Two output attenuator stages decrease this reference amplitude in operator selected 10 dB steps down to −60 dB, attenuation between the steps provided from the variable output attenuator control of the preamplifier. OUTPUT ATTENUATOR NO. 1 provides the −10 dB, −20 dB, and −30 dB attenuation ranges. OUTPUT ATTENUATOR NO. 2 is switched in to provide an additional 30 dB attenuation for the −40 dB, −50 dB, and −60 dB ranges. The ATTENUATION SELECTOR switch determines if the attenuators are to be bypassed for the 0 dB range, if just output attenuator No. 1 is to be used, or if both output attenuators are to be employed for the generator's output.

3.6 TRIGGER AND GATED CONTROL

The enabling of generator operation is controlled by allowing or preventing the selected timing capacitor to charge. For continuous operation, the TRIGGER AMPLIFIER maintains a positive level above the positive peak developed by the charging capacitors. This reverse biases (turns off) the START/STOP DIODE SWITCH, preventing the trigger amplifier from affecting continuous operation.

When the trigger amplifier outputs some level below the positive peak charging level, the diode switch is forward biased (turned on) to hold the charging level constant. Preventing the capacitors to charge to the positive peak stops operation and holds the output at some dc level called the trigger baseline. The trigger baseline is thus the level from which a waveform cycle starts and at where it will stop.

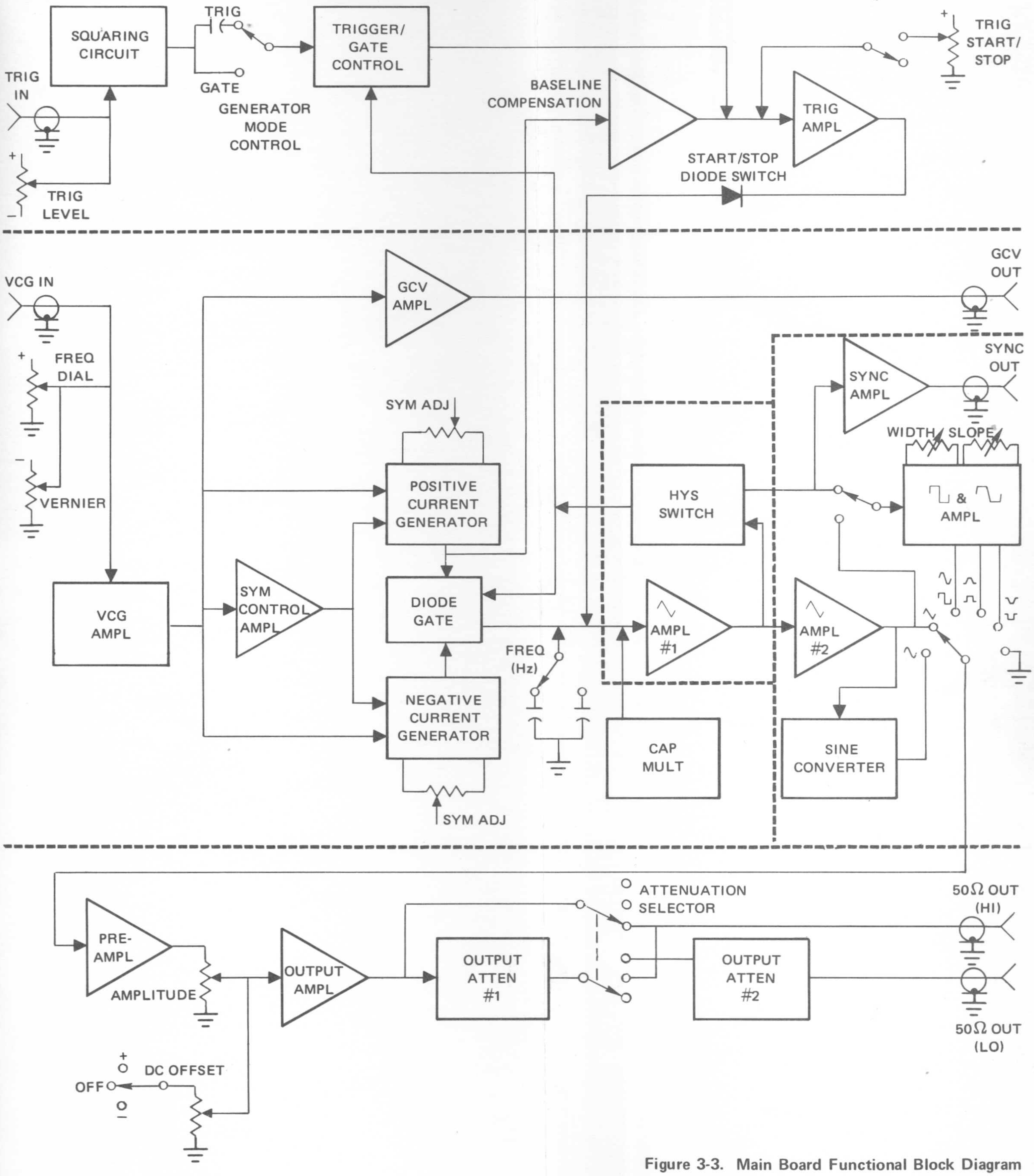


Figure 3-3. Main Board Functional Block Diagram

SECTION 4
PERFORMANCE VERIFICATION AND CALIBRATION

4.1 INTRODUCTION

This section provides instructions for verifying the performance of, and calibrating the Model 162 generator. The instructions are concise and written for the experienced electronics technician or field engineer. Performance is verified when the desired result of an adjustment is already present.

4.2 FACTORY REPAIR

Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

4.3 RECOMMENDED TEST EQUIPMENT

The following test equipment is recommended.

1. Oscilloscope: Tektronix Model 7704 or equivalent with
   a. High frequency amplifier (7A13)
   b. Differential amplifier (7A11) (250 MHz BW)
2. Distortion Analyzer: HP334A or equivalent
3. Spectrum Analyzer: > 600 kHz
4. Five-digit Frequency Counter: > 30 MHz

4.4 ACCESS INSTRUCTIONS

The Model 162 is packaged so that it can be quickly disassembled to afford access to the majority of components within the unit, while allowing the instrument to be operated.

To remove the dust cover (case) from the Model 162, the following procedure should be followed:

1. Unplug the ac line cord and unscrew the four captive screws on the rear panel.
2. Remove the rear panel and power supply.
3. Unplug power supply connector from power supply board. Slide dust cover off slowly.
4. At this time, the power supply can be remounted and the Model 162 may be operated normally.

4.5 CALIBRATION INSTRUCTIONS

The following paragraphs provide complete sequential calibration procedures for the Model 162 instrument. Calibration of the generator is organized in a sequence of six major groups. Each major group is a sequence of certain of the 26 individual selections and adjustments as listed below. The various calibration adjustments are located on the Main Board PC Assembly as identified in foldout Figure 4-3 at the end of this section. Each calibration adjustment is independent of subsequent adjustment settings; the subsequent adjustments, however, are dependent on previous adjustment settings.

CALIBRATION ADJUSTMENT SEQUENCE

Paragraph	Calibration Sequence	Adjustment Sequence
Power Supply		
4.5.2	Power Supply Regulation	R10
Main Board		
4.5.3	Triangle Offset and Amplitude	R282, R370, R51, R142, R231, R106, R111, R124
4.5.4	Time Symmetry	R29, R39
4.5.5	Sine Distortion	R352, R368, R142, R369
4.5.6	Frequency	R15, C64, C65, R19, R12, R9, R20, C62, R18, R17, R16, R10, R74, R68, R66
4.5.7	Square Wave Purity	R279, C110

4.5.1 Preliminary Procedures

Keep the generator covered and allow the unit to warm up for at least 30 minutes before calibration. Start the calibration by setting the front panel controls as follows:

FREQ (Hz)	X 1K
Frequency Dial	1.0
FREQ (Hz) VERNIER	Maximum cw (CAL)
WAVEFORM	∿ (Sine)
OUTPUT ATTEN (dB)	−10
OUTPUT ATTEN (dB) VARIABLE	3/4 cw
SYMMETRY	OFF
DC OFFSET	OFF
GEN MODE	CONT
TRIG START/STOP	0° CAL

4.5.2 Power Supply Regulation

1. Before connecting the unit to an ac source, check the ac line voltage. To make sure the 115/230 and HI/LO switches are set at the correct position, refer to Paragraph 2.2.1.

2. Connect ac power and turn on the generator. Connect a voltmeter ground lead to TP1 (common) and the other lead to TP2 (+15 V) on the main circuit board (see foldout Figure 4-5).

3. Adjust potentiometer R10 in the power supply assembly to obtain +15 Vdc ±20 mV at TP2. The power supply assembly is at the rear of the unit; the potentiometer, although located on the inner side of the printed circuit board, can be seen. Adjust by finger pressure.

4. Check voltage at TP3 for −15 Vdc ±50 mV, at TP4 for +24 Vdc ±400 mV, and at TP5 for −24 Vdc ±400 mV.

5. Check voltage at TP6 for +5 Vdc ±250 mV.

4.5.3 Triangle Offset and Amplitude Adjustment

1. Set the WAVEFORM selector to DC, the OUTPUT ATTEN switch to 0 dB, the OUTPUT ATTEN VARIABLE control to maximum ccw, and the GEN MODE switch to TRIG.

2. Connect the 50Ω OUT (HI) to the oscilloscope and load with a 50Ω terminator.

3. Adjust R282 to obtain output dc voltage of less than ±5 mV.

4. Set the OUTPUT ATTEN VARIABLE control to maximum cw.

NOTE

DC level may change between full cw and full ccw.

5. Adjust R370 to obtain output dc voltage of less than ±5 mV.

6. Repeat Steps 3 thru 5 once.

7. Set the frequency dial to 1.0, the WAVEFORM selector to ⋀⋁, and the GEN MODE switch to TRIG.

8. Use voltage at TP7 as reference; adjust R142 until voltage at TP8 equals the voltage at TP7 to within 10 mV.

9. Adjust R231 to obtain 0 Vdc ±10 mV at 50Ω OUT (HI).

10. Set GEN MODE switch to CONT, and set frequency at 1 kHz (1.0 X 1K). Connect the differential oscilloscope to TP8 and ground at TP1.

11. Adjust R106 to make the negative peak of the waveform −1.250 V ±10 mV.

NOTE

As the frequency is increased, the signal will become flatter; as the frequency is decreased, the signal will look more like a ⋀⋁.

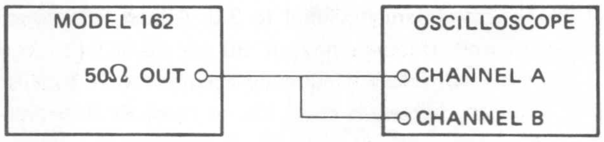
12. Connect the oscilloscope probe to TP9, and adjust R111 to make the ⋀⋁ waveform (approximately a 5 mV p-p signal) average voltage 0 V.

13. Adjust R124 for the square waveform at TP10 symmetrical above ground ±200 mV.

4.5.4 Time Symmetry Adjustment

1. Set the frequency dial to maximum cw, the FREQ (Hz) switch to X 100K and the WAVEFORM selector to ⊓⊔. Connect 50Ω OUT (HI) to the oscilloscope.

2. Set the oscilloscope time base to 0.2 ms/division. Adjust the FREQ VERNIER control until the oscilloscope screen is filled by approximately one cycle (see setup and display in Figure 4-1).



Frequency:	500 Hz
Waveform:	⊓⊔
Symmetry:	= 100 a/b%
Time Base:	0.2 ms/division
Sweep Magnified:	X 10
Trigger:	Internal and Alternate
Channel A:	Normal
Channel B:	Inverted

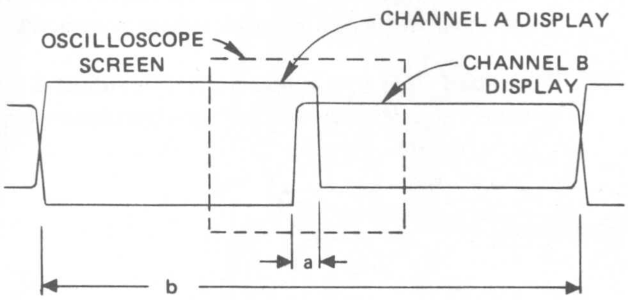


Figure 4-1. Alternate Time Symmetry Test Setup

3. Switch the oscilloscope trigger from + to −, and adjust R29 to obtain ⊓⊔ waveform time symmetry to within 0.5% (= 2 μs for 500 Hz).

4. Set the frequency dial to 2.0 and FREQ (Hz) to X 1K.
5. Set the oscilloscope time base to 50 μs. Use a similar procedure as above, and adjust R39 to obtain waveform time symmetry to within 0.1% (= 0.5 μs for 2 kHz.
6. Repeat Steps 1 thru 3 once.

4.5.5 Sine Distortion Adjustment

1. Set the FREQ (Hz) switch to X 1K, the frequency dial to 1.0 and the WAVEFORM selector to ∿ . Connect the 50Ω OUT (HI) to a distortion analyzer loaded with a 50Ω terminator. (See Figure 4-2 for test setup.)

2. Adjust R368 and R369 for minimum sine distortion, less than 0.15%. It may be necessary to reset R142 to achieve minimum sine distortion. R142 also affects the ⋀⋁ waveform offset.) Repeat Steps 7 and 9 of Paragraph 4.5.3 (Triangle Offset and Amplitude Adjustment).

NOTE

Trim resistor R351 may be changed for minimum sine distortion. Typical values are 825Ω and 909Ω.

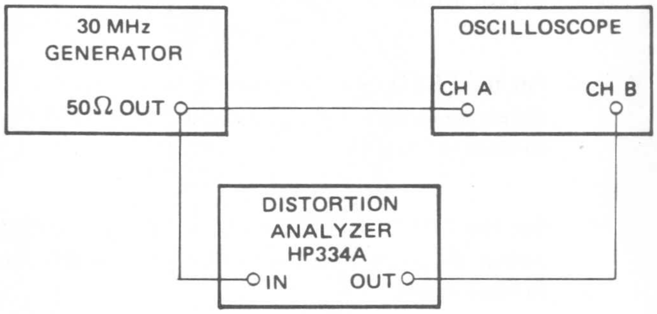


Figure 4-2. Distortion Test Setup

4.5.6 Frequency Calibration

1. Set the FREQ (Hz) switch to X 100K, the frequency dial to 0.03, the FREQ VERNIER maximum cw (CAL), and the WAVEFORM selector to ⊓⊔ . Connect 50Ω OUT (HI) to the oscilloscope.

2. Alternately short and open the VCG IN connector between its input and ground and adjust R15 at the same time until no observable frequency shift is seen on the oscilloscope.

3. Set the FREQ (Hz) switch to X 10M and the frequency dial to 2.0 Adjust C64 to obtain an output frequency of 20 MHz ±100 kHz. Select a different value of C65 if calibration cannot be achieved; each addition of 1 pF will reduce frequency by 200 kHz.

4. Set the FREQ (Hz) switch to 100K and the frequency dial to 3.0. Adjust R19 to obtain an output frequency of 300 kHz ±600 Hz.

NOTE

Select different value of R12 if frequency calibration in Steps 4, 9, and 10 cannot be achieved. Also, start from Step 3 again.

5. Set the frequency dial to 0.03 and the FREQ VERNIER control to maximum ccw. Adjust R9 to obtain an output frequency of 200 Hz ±20 Hz.

6. Repeat Steps 4 and 5 once.

7. Set the FREQ (Hz) switch to X 1M, the frequency dial to 3.0 and the FREQ VERNIER control to maximum cw (CAL). Adjust R20 to obtain an output frequency of 3 MHz ±10 kHz. Select a different value of C62 if calibration cannot be achieved; each addition of 10 pF will reduce frequency by 30 kHz.

8. Repeat Steps 3 and 7 once.

9. Set the FREQ (Hz) switch to X 10K. Adjust R18 to obtain an output frequency of 30 kHz ±60 Hz. (Refer to Note in Step 4.)

10. Set the FREQ (Hz) switch to X 1K. Adjust R17 to obtain an output frequency of 3 kHz ±6 Hz. (Refer to Note in Step 4.)

11. Set the FREQ (Hz) switch to X 100. Adjust R16 to obtain an output frequency of 300 Hz ±0.6 Hz (3.33 ms ±6 μs). Select a different value of R10 if calibration cannot be achieved.

12. Set the FREQ (Hz) switch to X 10 and the frequency dial to 0.1. Adjust R74 to obtain time symmetry of the ⊓⊔ waveform output better than 0.1%. Refer to Paragraph 4.5.4 (Time Symmetry Adjustment) for setup and measurement.

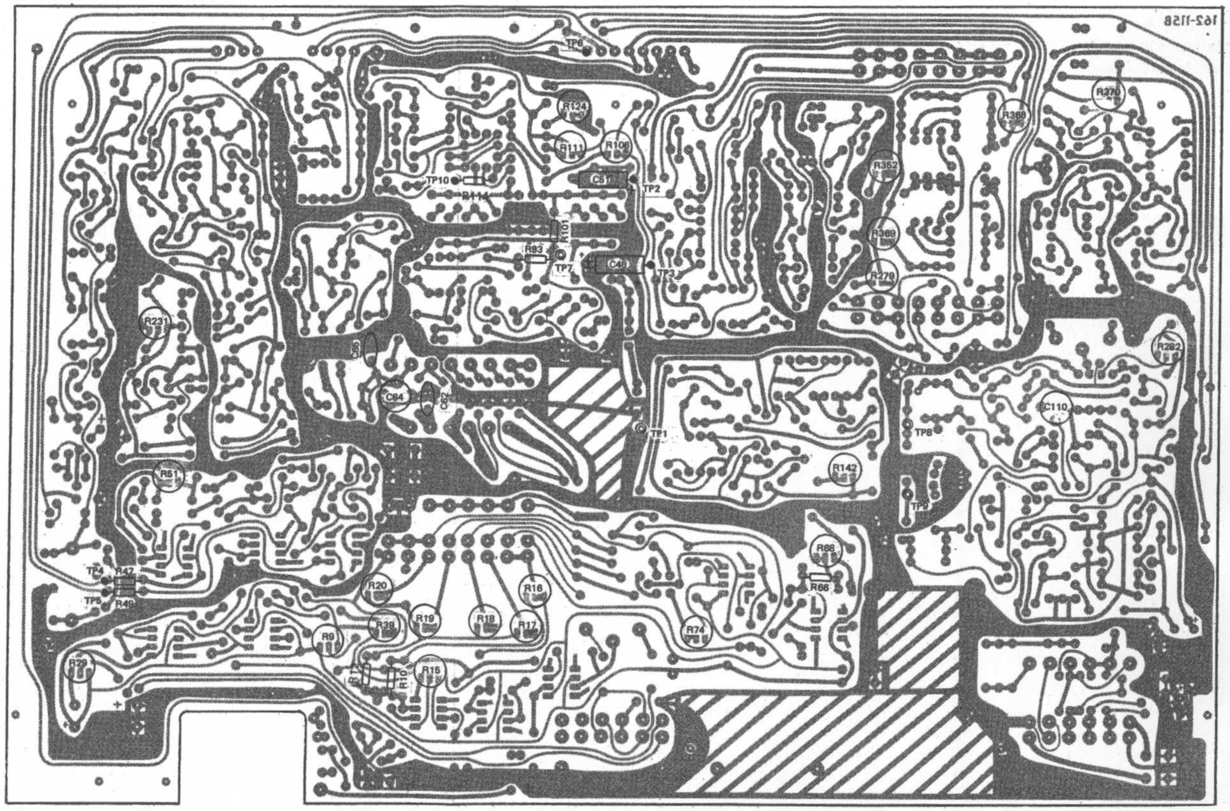
13. Set the frequency dial to 3.0. Adjust R68 to obtain an output frequency of 30 Hz ±0.06 Hz (33.3 ms ±6.0 μs). Check frequency accuracy at X 1 and X 0.1 ranges for better than 1%, or readjust R68. Select a different value of R66 if calibration cannot be achieved.

4.5.7 Square Wave Adjustment

1. Set the frequency dial to 1.0, the FREQ (Hz) switch to X 10K, the WAVEFORM selector to ⊓⊔ , and the OUTPUT ATTEN VERNIER to maximum cw. Adjust R279 to make the absolute negative peak voltage equal to the positive peak voltage within ±20 mV.

2. Set the FREQ (Hz) switch to X 1M. Adjust C110 to make a square waveform with the best square corner, but without overshoot.

TEST POINT	FUNCTION
TP1	COM
TP2	+15V
TP3	-15V
TP4	+24V
TP5	-24V
TP6	+5V
TP7	$\Lambda\!/_{1}$
TP8	$\Lambda\!/_{2}$
TP9	$\Lambda\!/_{dc}$
TP10	⊓⊔



MAIN BOARD ASSY
D162-015

Figure 4-3. Main Circuit Board Calibration Components

SECTION 5
TROUBLESHOOTING

5.1 CORRECTIVE MAINTENANCE

This section presents a systematic approach to troubleshooting. The section is organized in three parts as follows:

Part 1 (5.2). Troubleshooting Technique for Individual Components. Frequently you can quickly locate a defective component by this technique without understanding the function of the circuit. It is also a necessary technique when extensive troubleshooting to component level is required.

Part 2 (5.3). Troubleshooting Guide. Start by observing the symptom of malfunctioning; then use the guide to find the defective component or malfunctioning circuit.

Part 3 (5.4). Troubleshooting Procedure for Individual Circuits. This is a supplemental procedure to Part 2 and used when Part 2 has failed to locate the defective components. However, procedure in Part 2 should always be checked first; usually, it will refer to a specific procedure in Part 3.

5.2 TROUBLESHOOTING TECHNIQUE FOR INDIVIDUAL COMPONENTS

5.2.1 Transistor

1. A transistor is defective if more than one volt is measured across its base emitter junction in the forward direction.
2. A transistor when used as a switch may have a few volts reverse bias voltage.
3. If the collector and emitter voltages are the same, but the base emitter voltage is less than 500 mV forward voltage (or reversed bias), the transistor is defective.
4. A transistor is defective if its base current is larger than 10% of its emitter current (calculate currents from voltage across the base and emitter series resistors).
5. In a transistor differential pair (common emitter stages), either their base voltages are the same in normal operating condition, or the one with less forward voltage across its base emitter junction should be OFF (no collector current); otherwise, one of the transistors is defective. Example, Q56A and Q56B.

5.2.2 Diode

1. A diode is defective if across it there is greater than one volt (typically 0.7 volt) forward voltage.

5.2.3 Operational Amplifier; e.g., UA741C, LM318

1. The "+" and "−" inputs of an OP AMP will have less than 15 mV voltage difference when operating under normal conditions.
2. If the output voltage stays at maximum positive, its "+" input voltage should be more positive than its "−" input voltage, or vice versa; otherwise, the OP AMP is defective.
3. The input of an OP AMP should not draw more than 500 mA of current (calculate current from voltage across its input series resistor) or it is defective.

5.2.4 FET Transistor

1. No gate current should be drawn by the gate of an FET transistor. If so, the transistor is defective.
2. The gate-to-source voltage is always reverse biased under a normal operating condition; e.g., the source voltage is more positive than the gate voltage for 2N5485 and TP308, and the source voltage is more negative than gate voltage for a 2N5462. Otherwise, the FET is defective.

5.2.5 Capacitor

1. Shorted capacitors have zero volts across their terminals.
2. Opened capacitor can be located (but not always) by using a good capacitor connected in parallel with the capacitor under test and observing the resulting effect.

5.3 TROUBLESHOOTING GUIDE FOR MAIN CIRCUITS

The following troubleshooting guide is a list of possible malfunction symptoms, their probable causes, and prescribed remedies. To use the guide, locate the symptom listed and follow the corresponding procedures to locate the fault. If more intensive test is required to locate the fault, the guide will refer to a more specific procedure.

SYMPTOM	CORRECTIVE PROCEDURES
A. Output Waveform Problem	
1. Generator dead, blown fuse.	a. Replace fuse F1; if fuse blows again, refer to Paragraph 5.4.9.
2. All output waveforms are distorted or are not output, but SYNC OUT is normal.	a. Set OUTPUT ATTEN to 0 dB and DC OFFSET VARIABLE to MIN (ccw). b. If output voltage can be adjusted to ±10 V into open circuit with the DC OFFSET control, problem is in the preamplifier; refer to Paragraph 5.4.5. c. Otherwise, problem is in the output amplifier; also refer to Paragraph 5.4.5.
3. Power is on, but no output waveform at 50Ω OUT and SYNC OUT (GEN MODE at CONT).	a. Check for normal power supply voltage. b. Check the triangle generator circuits; refer to Paragraph 5.4.3.
4. Waveform amplitude and frequency jittering.	a. Power supply out of regulation due to ac line voltage being too low. Check line voltage and make sure the HI/LO switch setting in the power supply module is correct. b. Malfunctioning power supply; refer to Paragraphs 5.4.10 and 5.4.11.
B. Problems in General (Distortion, Oscillation, High Frequency Roll Off, etc.)	
1. Problem appears in all waveforms, but SYNC OUT is normal.	a. Problem is in the output amplifier if problem is not seen at junction of R392 and R394. b. Otherwise, problem is in the preamplifier; refer to Paragraphs 5.4.5 and 5.4.7. *(Note: Most oscillation and high frequency roll off problems are caused by defective capacitors.)*
2. Sine waveform problem only.	a. Problem is in the sine converter. C125 and C126 are shorted if no sine output; also refer to Step C.
3. Square waveform problem only.	a. Defective Q45, Q49, CR37, CR40 or the associated components, and switch wafer.
4. Trapezoidal waveform problem only.	a. Defective Q46, Q47, Q48, CR38, CR39 or the associated components, switch wafer, and controls.
5. Both square and trapezoidal waveform problems.	a. Defective Q50 - Q53, CR41 - CR48, and the associated components.
6. Trapezoidal WIDTH control problem.	a. Defective C95, R260 - R262 or the control potentiometer.
7. Trapezoidal SLOPE control problem.	a. Defective control potentiometer, R253 - R256.
8. Problem with triangle and sine waveforms only (or also trapezoidal).	a. Malfunctioning triangle No. 2; refer to Paragraphs 5.4.5 and 5.4.6. *(Note: High frequency roll off may be due to defective C44 - C49.)*

SYMPTOM	CORRECTIVE PROCEDURES
9. Problem in SYNC OUT.	a. Q25 - Q27 or the associated circuitry.
10. Problem in SYNC OUT and square waveform OUT.	a. Defective Q16.
11. Distorted waveform, or generator not running when X .001 Hz to X 10 Hz is selected.	a. Problem in capacitance multiplier; refer to Paragraph 5.4.4.
C. Sine Distortion Problem	
1. Distortion OK at 1 kHz, but out of specification at 10 kHz and/or 100 kHz.	a. Due to the triangle, amplitude into the sine converter is varied. Check for defective C33 - C36, C41 and the associated resistors.
2. Distortion out of specification in one or more frequency ranges.	a. Defective timing capacitor C53 - C62. In this case, triangle waveform will show nonlinear slope and distorted peak.
3. Distortion out of specification due to distorted or unsymmetrical triangle.	a. If the leakage current of Q9, C22, C65, and C64 is large, it will cause non-linear triangle and sine distortion in all frequencies. b. Distortion is caused by out-of-calibration or malfunctioning current generator if square wave time symmetry is off by more than 0.5%.
4. Half of the sine waveform is missing.	a. Defective R368 or R369.
5. Triangle waveform normal, but sine waveform distorted.	a. Check for normal triangle at sine converter input. It should be ±1.25 V p-p, and have better than 0.5% time symmetry and linear slope. b. If no defective resistor is found, replace the diode set CR54 - CR65.
6. Distortion out of specification at frequencies greater than 1 MHz.	a. Problem is in the triangle amplifier No. 1 and hysteresis switch if frequency accuracy at X 10 MHz range is also out of specification. b. Check for defective capacitors, CR9 and CR10. c. Problem is in the preamplifier and output amplifier if square wave rise/fall time also does not meet the specification. Check for defective capacitor in the circuit. d. Defective CR14 - CR17, C22, C65 and C64. e. Defective C10 - C13, which may also cause frequency jumping when dial is rotated slowly (at X 10 MHz).
D. Time Symmetry Problem	
1. Positive slope of triangle remains constant when frequency dial is varied.	a. Defective IC3, IC6, Q1, Q3, Q5, C7 and the associated circuitry.
2. Negative slope of triangle remains constant when frequency dial is varied.	a. Defective IC5, IC7, Q2, Q4, Q6, and the associated circuitry.
3. Symmetry off a few percent at 3.0 of dial, but not much worse at .03 of dial.	a. R39 is out of calibration or defective. b. Defective R38, R40, R41, R46, R50, R53, or R59.

	SYMPTOM	CORRECTIVE PROCEDURES
4.	Symmetry off only if dial is set close to, or above 3.0.	a. IC5 is saturated due to frequency being out of calibration. b. IDSS (drain current, source shorted) of Q2 is too small; select a 2N5462 with IDSS of 3 mA.
5.	Symmetry off, several times worse if frequency dial and vernier is set to minimum.	a. Defective Q9, Q3, Q5, C10, CR15 or CR16 if the triangle at 50Ω OUT rises faster than it falls. b. Defective Q4, Q6, C11, CR14 or CR17 if the triangle at 50Ω OUT falls faster than it rises.
6.	Symmetry is out of specification at X 10 frequency range, and gets proportionally worse as frequency is decreased.	a. Defective Q8. b. R74 is out of calibration.
E.	**Waveform Problem**	
1.	Nonlinear or distorted triangle at one particular frequency range.	a. Check for defective frequency range capacitor C53 - C62 or C18.
2.	Nonlinear or distorted triangle at all frequencies.	a. Check for defective C22, C26, C64, Q9, CR14 - CR17.
3.	Nonlinear triangle only at its peak.	a. R124 is out of calibration. b. Square wave at E of Q23, E of Q24 is not symmetrical about ground due to defective Q23, Q24, CR14 - CR17 or the associated circuitry.
4.	rise/fall time abnormally slow; also, sine wave rolling off at high frequency. High frequency oscillation on all waveforms.	a. Check for defective capacitor in output amplifier if waveform at E of Q72 is normal. (Rise/fall time less than 10 ns.) b. Otherwise, check for defective capacitor in the preamplifier.
5.	Nonlinear triangle at low frequency (X 10 to X 0.001 range).	a. Defective C18. b. Defective Q8, IC9, IC10, and the associated circuitry.
F.	**Frequency Accuracy Problem**	
1.	Frequency out of specification even at X 1 kHz range.	a. Check for normal triangle waveform at E of Q11 (±1.25 V ±5 mV and time symmetry within 0.5%), at 3 kHz. b. Defective dial potentiometer or mismatched dial and potentiometer (numbers marked on the dial and potentiometer should be the same), if frequency is out of specification at the same portion of the dial in every range. c. Defective current generator, especially IC1, IC5 and Q2, if triangle is unsymmetrical.
2.	Frequency out of specification at X 10 kHz, X 100 kHz, or X 1 MHz ranges.	a. Check for defective C33 - C36, C41. b. Check for defective Q13.
3.	Frequency out of specification at X 10 MHz range.	a. Defective Q13. b. Defective C31, C32, C37, C38, C26, or C41. c. Check for defective CR9 and CR10 (to check, set frequency to 3 kHz and compare waveform at the diode as shown in Figure 5-1).

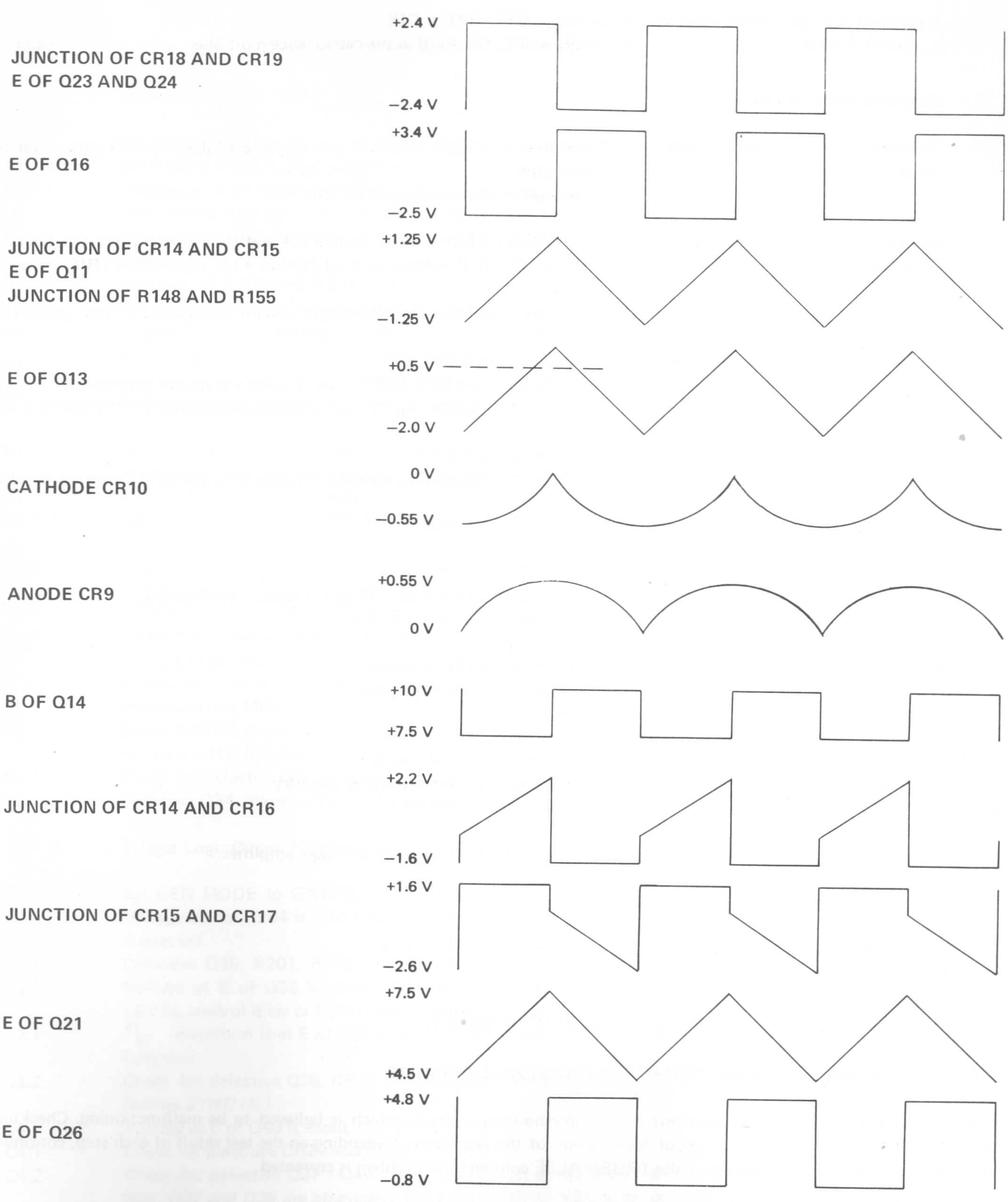


Figure 5-1. Key Waveforms of ∿ Amplifier No. 1, Amplifier No. 2, Comparator and Hysteresis Switch

SYMPTOM	CORRECTIVE PROCEDURES
4. Frequency out of specification at X .001 to X 10 Hz range.	a. Defective R77 - R81 or C18. b. Defective IC9, Q8, IC10 in the capacitance multiplier.
G. Generator Mode Problem	
1. Generator not running in CONT mode.	a. Problem is in trigger circuit if voltage at E of Q44 is +1.2 volts; refer to Paragraph 5.4.1. b. Otherwise, check for defective CR36.
2. Generator runs continuously in all GEN modes.	a. TRIG START/STOP control is at VAR and its variable is set too far cw. b. Defective CR36 if voltage at E of Q44 is +1.2 volts when TRIG mode is selected. c. Otherwise, troubleshooting the trigger circuit is covered in Paragraph 5.4.1.
3. Both TRIG and GATED modes work as if in GATED mode.	a. Defective Q33 or CR24. b. Check for defective GEN MODE switch wafer and circuit connection. c. Otherwise, troubleshooting the squaring circuit is covered in Paragraph 5.4.1B.
4. Both TRIG and GATED modes work as if in TRIG mode.	a. Defective Q33 or C73. b. Otherwise, troubleshooting the squaring circuit is covered in Paragraph 5.4.1B.
5. TRIG mode not working, but GATED mode OK.	a. Defective C76 or CR24.
6. MAN TRIG not working.	a. Defective Q31, C77, CR23, C75 or the associated circuitry. b. Check MAN TRIG switch setting.
7. TRIG LEVEL control has no affect, or loads the ±15 volt power supply down when set to its extremes.	a. Defective C72, R182, or wiring. b. Defective control potentiometer.
8. TRIGGER START/STOP level (baseline) varies more than 100 mV, at maximum output voltage.	a. R51 is not properly calibrated. b. Defective IC8, Q7, and associated circuitry. c. Mismatched CR36 and CR4.
9. High frequency oscillation on TRIGGER START/STOP level, or baseline.	a. Defective capacitor C82 - C87 in trigger amplifier.
10. Generator does not trigger with high frequency trigger as specified.	a. Defective CR24, C71, or C75.
11. Other trigger problems.	a. Refer to Paragraph 5.4.

5.4 TROUBLESHOOTING PROCEDURE FOR INDIVIDUAL CIRCUITS

The following is a step-by-step procedure for troubleshooting a circuit which is believed to be malfunctioning. Checking should always start from the first step of each section of the procedure. Depending on the test result of each step, continue the test in sequence as indicated under the TRUE/FALSE column until problem is corrected.

Example: In Step A3, from the test result, if voltage at emitter of Q34 is less than −0.1 volt, continue the test in Step A4; otherwise, go to Step B and continue the test at Step B1.

5.4.1 Troubleshooting of Trigger Circuit

STEP	PROCEDURE	IF TRUE, GO TO	IF FALSE, GO TO
A	**Quick Check of Trigger Circuit**		
A1	Set GEN MODE to GATED.	A2	
A2	Set TRIG LEVEL control fully ccw.	A3	
A3	Voltage at E of Q34 is less than −0.1 volt, greater than +3.5 volts with TRIG LEVEL fully cw. (Squaring circuit is OK if true.)	A4	B
A4	Voltage at E of Q40 is about +1.5 volts, −1.5 volts if TRIG LEVEL is fully cw.	A5	C
A5	Junction of R223 and R237 is zero volt. Also, E of Q44 is more positive than −2 volts but less positive than +0.6 volt.	A6	D
A6	Trigger circuit is working normally. Refer to Paragraph 5.3G for other trigger or gated mode problems.		
B	**Squaring Circuit Problem**		
B1	With TRIG LEVEL control fully ccw, CR24 is OFF (zero volt across it); fully cw, CR24 is ON (at least 0.5 volt across it).	B4	B2.1
B2	E of Q30 is about +5 volts.	B3	B3
B2.1	Defective Q30, R188, R189. May be due to extra loading, such as C74 being shorted.		
B3	E of Q31 is zero volt, but drops to −14 volts when MAN TRIG switch is depressed.	B4	B3.1
B3.1	Defective Q31, MAN TRIG switch, or the associated circuitry.		B3.2
B3.2	Check for defective Q28, Q29, CR24, and TRIG LEVEL control.		
B4	Voltage at junction of R201 and R199 is −15 V when CONT mode is selected; +15 V for TRIG mode, and +4.5 V for GATED mode.		
B4.1	Defective GEN MODE switch.		
B5	Select GATED mode. C of Q32 is +4 V if TRIG LEVEL is fully cw, but zero volt if fully ccw.	B6	B5.1
B5.1	Check for defective Q32 and Q33.		B6
B6	Defective Q34. *(Note: Q34 is a voltage follower.)*		A4
C	**Trigger Logic Circuit Problem**		
C1	Set GEN MODE to GATED, and TRIG LEVEL control fully ccw.	C2	
C2	Voltage across R204 is zero volt, more than 3 volts if CONT mode is selected.	C3	C2.1
C2.1	Defective Q35, R201, R202, switch wafer SW5-B, or connections.		
C3	Voltage at E of Q36 is about +2 volts, waveform if TRIG LEVEL control is cw or CONT mode is selected.	C4	C3.1
C3.1	waveform is at E of Q36 in GATED mode with TRIG LEVEL fully ccw.	C4	C3.2
C3.2	Check for defective Q36, CR26 or C78. *(Note: Voltage at E of Q36 follows SYNC IN.)*		
C4	Voltage at E of Q40 is about +1.5 volts.	D	C4.1
C4.1	Check for defective CR27 and CR28.		C4.2
C4.2	Check for defective Q37 - Q40. *(Note: This circuit works like a flip-flop; Q37 and Q38 are alternately ON.)* Set TRIG LEVEL to cw or ccw, and check for correct voltage levels at E of Q37, Q39 and Q40 as shown in Figure 5-2 under GATED mode operation.		

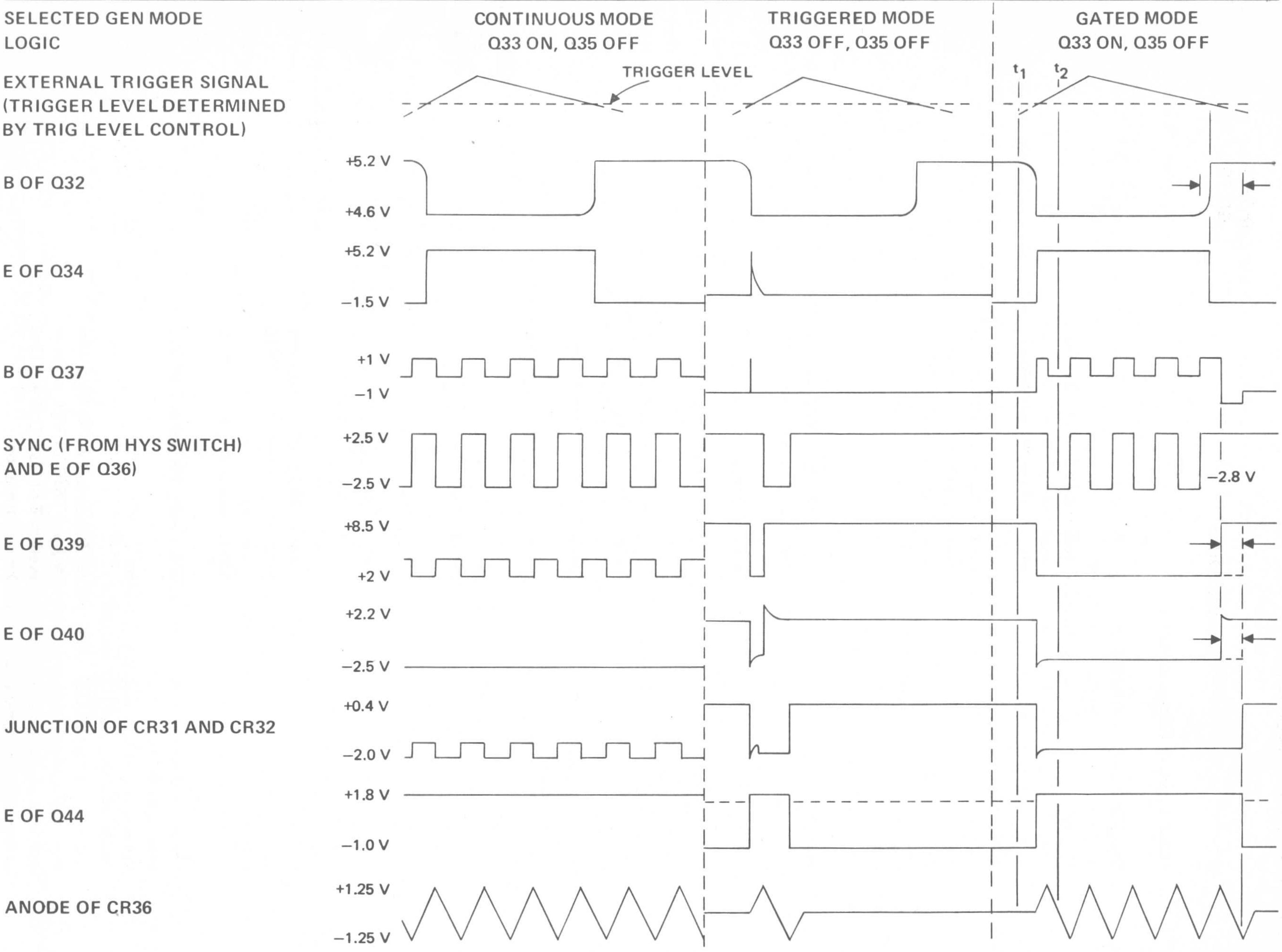


Figure 5-2. Typical Voltage and Waveforms for Trigger Circuit

STEP	PROCEDURE	IF TRUE, GO TO	IF FALSE, GO TO
D	**Trigger Amplifier Problem**		
D1	Set GEN MODE to GATED and TRIG LEVEL control fully ccw.	D2	
D2	Voltage at E of Q44 is about −0.7 volt (TRIG START/STOP at 0° CAL), +1.5 volts and generator is oscillating, if TRIG LEVEL is fully cw.	D2.1	D3
D2.1	Voltage at E of Q44 can be varied from −2 volts to +0.6 volt if TRIG START/STOP is set to VAR and its VARIABLE control is rotated.	D2.2	D3
D2.2	Trigger amplifier is operating normally.		
D3	Voltage across R229 is less than 1.5 volts.	D4	D3.1
D3.1	Baseline compensation circuit is malfunctioning; check for defective IC8 and its circuitry.		
D4	Zero voltage at junction of R223 and R237 (amplifier summing node).	D5	D4.1
D4.1	Check for defective Q41 - Q44. *Note: Voltage at E of Q42 is +8 volts, and E of Q43 is −8 volts. Q44 is a voltage follower.)* High frequency oscillation at E of Q44 indicates defective capacitors C82 - C87.		
D5	Check for defective CR31 - CR35.		
5.4.2	**VCG Amplifier and Current Generator Troubleshooting Procedure**		
E	**Current Generator Problem**		
E1	Set FREQ (Hz) to X 1K or more, SYMMETRY OFF, and FREQ VERNIER at CAL.	E2	
E2	Rotate the frequency dial from full cw to full ccw and observe voltage variation as described in Steps E3 thru E7.		
E3	Voltage at junction of R22 and R24 varies from 0 volt to about −5.7 volts.	E4	F
E4	Voltage at E of Q5 varies from about +14.5 volts to +6.7 volts.	E5	G
E5	There is no observable voltage (less than 1 μV) seen across R55.	E6	G4.1
E6	Voltage at E of Q6 varies from −15 volts to −9.3 volts.	E7	H
E7	There is no observable voltage seen across R56.	E8	H2.3
E8	Both current generators are operating properly.		
F	**VCG Amplifier Problem**		
F1	Troubleshooting hints: a. Pin 2 and pin 3 of IC1 is always zero volt. b. Under normal operating conditions, voltage at pin 6 is between 0 and −10 volts when dial is rotated from full cw to full ccw. c. Voltage at pin 6 will cut to half if X .001 Hz FREQ range is selected.	F2	
F2	If VCG amplifier works normally.	E4	
G	**Positive Current Generator Problem**		
G1	Voltage at pin 2 and pin 3 of IC3 is zero volt.	G2	G1.1
G1.1	Check for defective IC3 and Q1; voltage across R35 should be zero volt.		
G2	Voltage at pin 2 of IC5 varies from 0 to −5.7 volts when dial is rotated cw to ccw.	G3	H1.1

STEP	PROCEDURE	IF TRUE, GO TO	IF FALSE, GO TO
G3	Voltage at D of Q1 varies from about +14.5 volts to +6.7 volts when dial is rotated cw to ccw.		
G3.1	Check for defective R41, R40, C7, and SYMMETRY switch.		G.4
G4	Repeat Step E2, E4, and E5.	E2	G4.1
G4.1	Check for defective IC6, Q3, Q5, and the associated circuitry. *(Note: Check for correct power supply voltage and defective capacitor C8, C10, or C12.)*		
H	**Negative Current Generator Problem**		
H1	Voltage at S of Q2 varies from 0 volt to about −5.7 volts when dial is rotated cw to ccw.	H2	H1.1
H1.1	Check for defective IC5 and Q2.		
H2	Voltage at D of Q2 varies from −15 volts to −9.3 volts, and zero volt is across R37 when dial is rotated cw to ccw.	H3	H2.1
H2.1	Zero voltage at pin 2 of IC3.	H2.2	G
H2.2	Check for defective R40, R41, C7, and SYMMETRY switch.	H2.3	
H2.3	Check for defective IC7, Q4, Q6, and the associated circuitry. *(Note: Check for correct power supply voltage and defective capacitor C9, C11, or C13.)*		
H3	Repeat Steps E2, E6, and E7.	E2	H2.3
5.4.3	**Triangle Generator Troubleshooting**		
I	**Start/stop Switch and Diode Gate Problems**		
I1	A ±1.25 V triangle is seen at E of Q11 in CONT mode.	I1.1	I1.2
I1.1	Triangle generator is running; refer to Paragraph 5.3 for other problems.	5.3	
I1.2	Voltage at E of Q44 (trigger amplifier) is greater than +1.2 volts.	I1.4	I1.3
I1.3	Troubleshoot the trigger circuit.	5.4.1	
I1.4	CR36 is shorted.		I2
I2	Set dial to 3.0, FREQ (Hz) to X 1K, and SYMMETRY OFF.	I3	
I3	Both voltages across R163 and R164 are about 500 mV; voltages will decrease if dial is rotated cw.		I3.1
I3.1	Troubleshoot the current generator.	5.4.2	I4
I4	Voltage difference between G of Q9 and E of Q11 is less than 300 mV.	I5	J
I5	Voltage at E of Q11 is within ±1.25 volts.	I7	K
I6	Check for shorted C22, C64, or C65.		I7
I7	Check for defective Q23, Q24, C68, and the associated circuitry. *(Note: Q23 and Q24 are voltage followers, the voltages of which should be the same as C of Q14.)*		I8
I8	Voltage at C of Q14 is either +2.4 ±0.5 volt or −2.4 ±0.5 volt.		
I8.1	R124 is out of calibration.		K
I9	Check for defective CR14 - CR17. *(Note: None should have more than 900 mV forward voltage.)*		
J	**Triangle Amplifier No. 1 Problem**		
J1	6.4 volts ±0.6 volt across both CR6 and CR8.	J2	
J1.1	Defective CR6, CR8, C24 or C25.		

STEP	PROCEDURE	IF TRUE, GO TO	IF FALSE, GO TO
J2	Check for defective Q11 and Q12. *(Note: Q11 and Q12 are voltage followers.)*		
J3	Check for defective Q9 and Q10. *(Note: G to S voltage should be reversed bias. Voltage across R86 and R87 are the same.)*		J4
J4	Check for shorted C27.		
K	**Hysteresis Switch Problem**		
K1	Voltage at pins 2 and 8 of IC11 are about –2 volts.	K2	K1.1
K1.1	Voltage across R118 and R121 is less than 30 mV.	K1.2	K4.1
K1.2	Defective R119, R123, or R124.		
K2	Voltage at pins 3 and 9 of IC11 are about 0.7 volt below that at pins 2 and 8.	K3	K4.1
K3	Voltage at B of Q14 is no more than one volt less than that at B of Q15.	K3.1	K3.3
K3.1	Q14 is ON and Q15 is OFF (zero volt across R128 and 5 volts across R114).	K4	K3.2
K3.2	Check for defective Q14 and Q15.		
K3.3	Q14 is OFF and Q15 is ON (5 volts across R128 and zero volt across R114).	K4	K3.2
K4	Voltage at B of Q14 is 7.5 volts ±1 volt.	K5	K4.1
K5	Voltage at pin 7 of IC11 is within 0 and 200 mV.	K6	K4.1
K6	Voltage at E of Q11 is greater than +1.25 volts.	K8	K7
K7	Voltage at E of Q11 is less than –1.25 volts.	K9	I5
K8	Voltage at pin 4 of IC11 is greater than zero volt.	K3.3	K8.1
K8.1	Check for defective R101, R109, R110, R111, CR10, and C35 - C38.		
K9	Voltage at pin 1 of IC11 is less than zero volt.	K3.1	K9.1
K9.1	Check for defective R100, R108, R107, R106, CR9, and C31 - C34.		

5.4.4 Troubleshooting the Capacitance Multiplier Circuit

STEP	PROCEDURE	IF TRUE, GO TO	IF FALSE, GO TO
L	**Capacitance Multiplier Problem**		
L1	Set FREQ (Hz) to X 10 and check for correct waveform as shown in Figure 5-3.	L1.1	L2
L1.1	Capacitance multiplier is running. Refer to Paragraph 5.3 for other capacitance multiplier related problems.	5.3	
L2	Check the multiplier statically by setting FREQ (Hz) to X 100. *(Note: The multiplier is disconnected from the main generator and therefore the circuit is under a dc bias condition.)*	L3	
L3	Voltage at wiper of SW1-C is zero volt.	L4	L3.1
L3.1	Check for defective switch wafer SW1-C and related circuitry.		
L4	Voltage at pin 6 of IC9 is 0 ±200 mV.	L5	L4.1
L4.1	Check for defective IC9, C17, and R64 - R68.		
L5	Voltage at pin 6 of IC10 is zero volt (or adjustable to zero with R74).	L6	L5.1
L5.1	Check for defective IC10, Q8, and C21. *(Note: Voltages at S of Q8A and Q8B are equal and more positive than voltages at G's under normal operating condition.)*		
L6	Short wiper of SW1-C to ground with a jumper wire. Switch FREQ (Hz) control between X 10 Hz and X .001 Hz and observe that voltage at wiper of SW1-B changes no more than 10 mV.	L1	L6.1

STEP	PROCEDURE	IF TRUE, GO TO	IF FALSE, GO TO
L6.1	Defective Q8, or Q8 has IDSS less than 1 mA and should be replaced. *(Note: Defective Q8 will cause frequency accuracy and time symmetry problem at low frequency, especially at X .001 Hz range.)*		

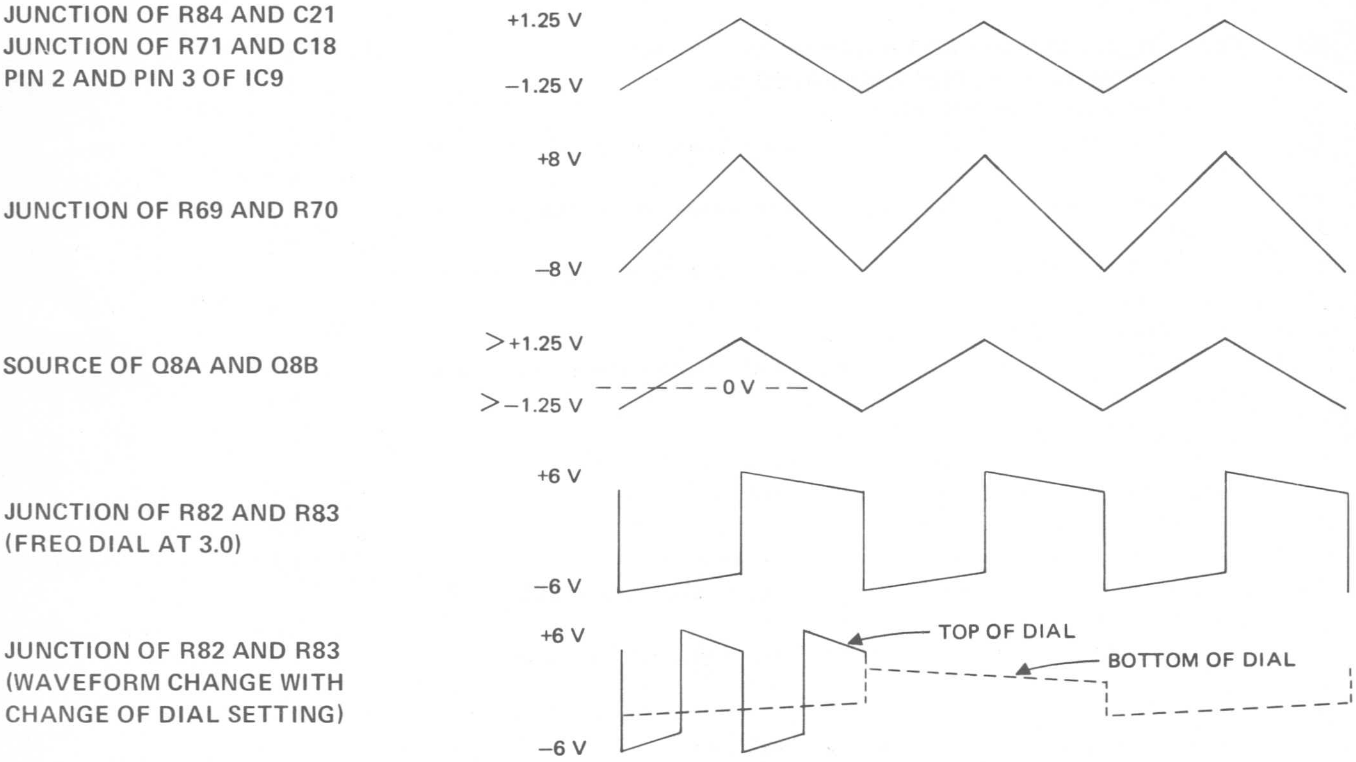


Figure 5-3. Key Waveforms of Capacitance Multiplier

5.4.5 Amplifier Troubleshooting Hints

1. If the output of an amplifier is saturated at a portion of the input waveform or all the time, the simplest method is to follow Paragraph 5.2 to locate a defective semiconductor or capacitor.

2. If high frequency oscillation is seen at the output of an amplifier, usually it is due to a defective capacitor. Sometimes, a defective capacitor can be located by touching the PC circuit traces to find the most signal sensitive area.

3. Look for burnt or overheated components.

4. Slow frequency response and rise/fall times are usually due to a defective capacitor. Use a good capacitor to jumper across each of the capacitors in the amplifier to locate the open-circuit capacitor.

5.4.6 Triangle Amplifier No. 2 Troubleshooting Hints

1. The triangle amplifier no. 2 circuit is a unity gain amplifier. Voltage at B of Q17 is the same as at the B of 19. A ±1.25 V p-p triangle signal is seen at these points when the generator is running.

2. Voltage at E of Q18 is about +11 volts.

3. Voltage at E of Q20 is about −7.5 volts.

4. A 2.5 V p-p triangle, with +5.5 volt offset should be seen at E of Q21 when the generator is running.

5. R142 adjusts the dc offset of the amplifier.

5.4.7 Preamplifier Troubleshooting Hints

1. The preamplifier circuit is an inverting amplifier thru which the selected waveform passes before going to the output amplifier.

2. The output waveform at junction of R393 and R394 is about 5.3 V p-p.

3. Voltage at junction of C129 and C130 is zero volt (summing junction).

4. Voltages across R385 and R390 are equal, about 8 volts.

5. Q67, Q68, and Q69 are dc-bias elements for the amplifier.

6. C133 is switched in or out of the circuit, depending on the waveform selected, to optimize the frequency response.

7. Defective C128 causes overshoot and dipping of square wave corners.

5.4.8 Output Amplifier Troubleshooting Hints

1. Like the preamplifier, the output amplifier is also an inverting amplifier.

2. Junction of C109 and C111 is zero volt (summing junction).

3. Voltages across R305 and R313 are equal, about 8 volts.

4. Q54, Q55 and Q56 are dc-bias elements.

5. Q61 and Q62 compose the output current limiting stage. Normally the two transistors do not conduct unless the output loading current exceeds 140 mA.

6. If C105 is opened, the square wave corners will show excessive rounding.

7. Defective C107 causes overshoot and dipping of square wave corners.

8. Defective C109 - C115 will cause high frequency waveform roll-off or oscillation on the waveform.

5.4.9 To Locate Short Circuit Components

1. Check for normal impedance and/or loading current to determine if the source of short is in power supply or other circuit. Refer to Paragraph 5.4.10.

2. Short circuit component can be located by troubleshooting the malfunctioning circuit if the short circuit does not cause low power supply voltage or blowing fuse.

3. If power supply voltage is low but fuse is not blown immediately, look for overheated components, burnt parts, or discolored circuit board.

4. Inspect the circuit board carefully for any solder bridges.

5. Localize the short circuit to one or a pair of power supply circuits by impedance measurement; refer to Paragraph 5.4.10. Then disconnect power supply voltages to each part of the circuit by removing jumper or series resistor (usually 10Ω to 100Ω) along the power supply path until the short circuit area is isolated. Then locate the short in that area. Power supply transistors and bypass capacitors are the most frequently shorted components.

5.4.10 Loading Current and Impedance of Power Supply

Typical current and impedance of each power supply loading are provided as a reference in case symptoms of a short circuit are observed. Before making any measurement, set the generator controls as follows:

FREQ	X 1K
DIAL	3.0
SYMMETRY	OFF
WAVEFORM	∿
OUTPUT ATTEN (dB)	−10 dB (no load at 50Ω OUT)
OUTPUT VARIABLE	Manually cw
GEN MODE	GATED
DC OFFSET	OFF
TRIG START/STOP	0° CAL

1. Loading current is measured by first unsoldering the power supply wire to the circuit board from the power supply connector so as to connect an ammeter in between.

2. Impedance is measured at the same point as above relative to the ground on the PC board, unless otherwise specified.

Typical impedance across and loading current into the main circuit board power supply are shown in the following table:

Main Circuit Board

POWER SUPPLY	IMPEDANCE	LOADING CURRENT
+15 volts	400	400 mA
−15 volts	600	380 mA
+24 volts	20K	50 mA
−24 volts	20K	45 mA
+ 5 volts		0
between ±15 volts	1K	—
between ±24 volts	25K	—

Note: Impedance and current are accurate to within ±20% and will vary if panel controls are set differently.

5.4.11 Power Supply Troubleshooting Hints

1. Unplug the power supply connector from the main board if power supply voltage is out of regulation.

2. 60 cycle ripple on supply voltage may be due to wrong HI/LO switch selection. Check ac line voltage and select the proper switch setting accordingly.

3. Power supply voltages are interrelated. Malfunctioning +15 volt supply will cause the −15, ±24 volt supplies to be out of regulation. Malfunctioning ±24 volt supplies, however, will not affect the others.

4. Q3, Q7, Q12, and Q16 are current limiting transistors which do not conduct under normal operating conditions. Supply voltage will be zero if these transistors have a short circuit.

5. The power supply voltages being normal without a load and the voltage being low under a normal load indicate Q2, Q6, Q10 or Q14 as being an open circuit.

6. Fuse blown with the power supply being plugged in may be due to wire insulation being broken, shorted transformer, power transistor shorted to heat sink, defective CR1 to CR8, or shorted power supply bypass capacitor. Isolate the short by disconnecting each part of the circuit.

SECTION 6
PARTS LISTS AND SCHEMATIC DIAGRAMS

6.1 DRAWINGS

Assembly drawings are positioned adjacent to the schematics. Additional voltage or waveform information, beyond that given in the circuit description, may be shown on the schematic diagrams, at test points and key locations throughout the instrument.

6.2 ADDENDA

Under Wavetek's product improvement program, the latest electronic designs and circuits are incorporated into each Wavetek instrument as quickly as development and testing permit. Because of the time needed to compose and print instruction manuals, it is not always possible to include the most recent changes in the initial printing. Whenever this occurs, addendum pages are prepared to summarize the changes made and are inserted immediately inside the rear cover. If no such pages exist, the manual is correct as printed.

6.3 ORDERING PARTS

When ordering spare parts, please specify part number, circuit reference, board, serial number of unit, and if applicable, the function performed.

6.4 DRAWINGS

The following assembly drawings (with parts lists) and schematics are in the arrangement shown below:

Chassis	Assembly Drawing and Parts List	162-000	Sheets 1-3
	Schematic	162-200	
Main Board	Assembly Drawing and Parts List	162-015	Sheets 1-5
	Schematic	162-215	Sheets 1-4
Rear Panel	Assembly Drawing and Parts List	162-001	
Power Supply Board	Assembly Drawing and Parts List	162-030	Sheets 1, 2
	Schematic	162-230	
Switch Bracket	Assembly Drawing and Parts List	162-004	

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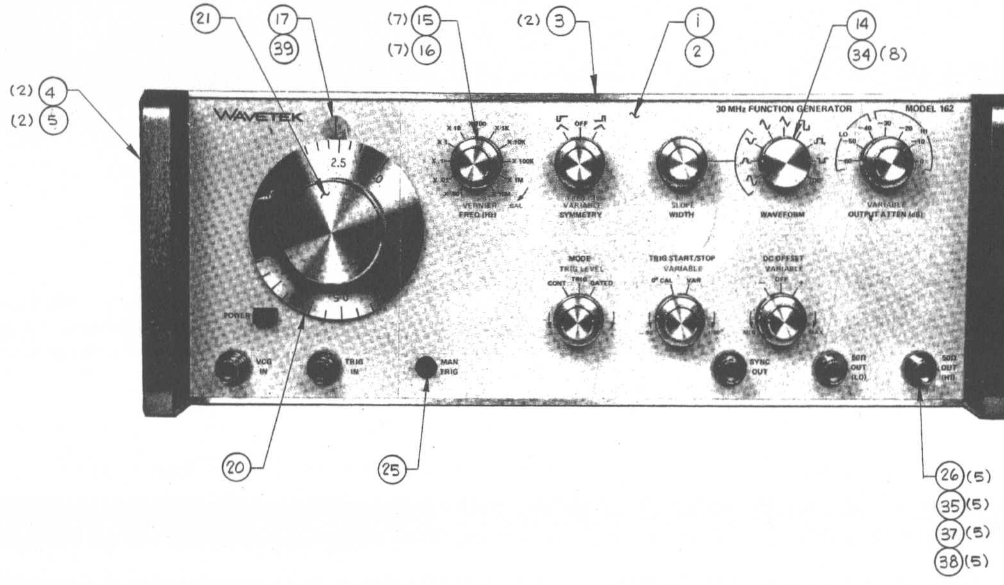
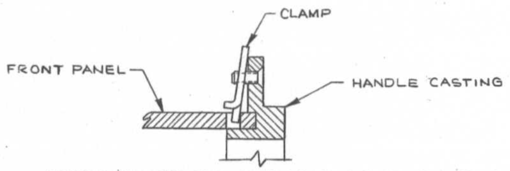
REV	ECN	BY	DATE	APP
B	ECN # 823	Ro	8/29/74	
C	ECN # 1074	Ro	9/25/74	
D	ECN 1113	Ro	9/25/74	
E	ECN 1052	Ro	10/1/74	
F	ECN 1088	Ro	10/10/74	
G	ECN 1115	Ro	10/19/74	
H	ECN 1160	Ro	12/16/74	



PARTS LIST

LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
1	SUB PANEL	WAVETEK	23338	C162-301	1
2	FRONT PANEL			C162-300	1
3	PANEL TRIM			B147-018	2
4	HANDLE			C147-364	2
5	HANDLE TRIM			B147-345	2
6	SIDE PLATE			B147-378	2
7	SUPPORT BAR			B147-347	1
8	CLAMP			A147-316	4
9	REAR PANEL ASSY			D162-001	1
10	MAIN BOARD			D162-015	1
11	SWITCH BRACKET			D162-004	1
12	COVER, ASSY.			C147-024	1
13					
14	KNOB			B130-314	1
15	KNOB, COAX			B130-309	7
16	KNOB, SMALL			B130-354	7
17	LENS			A141-317	1
18	POWER SWITCH ROD			B147-382	1
19	POTENTIOMETER			A131-R1A	1
20	DIAL			B130-333	1
21	DIAL KNOB			B130-308	1
22					
23					
24	POWER CORD	BELDEN	16428	17250-B	1
25	SWITCH (MOMENTARY)	C & K	09353	7108PDCN	1
26	BNC CONNECTOR	KINGS	91836	KC 7946	5
27	RESISTOR, M.F. 1/8W 1% 56.2Ω	CORNING	16299	RN55D	2
28	RESISTOR, M.F. 1/8W 1% 825Ω			RN55D	1
29					
30	U-NUT	TINNERMAN		C8681-832-24	4
31	CHASSIS BLOCK	USECO	88245	1591B-11	2
32	SCREW, P.HD., BLK.OX., 8/32 X 5/8	COMMERCIAL		8/32 X 5/8"	4
33	TERMINAL	USECO	88245	1401A-9	1
34	BUSHING	THOMPSON	96881	4L2FF	8
35	WASHER (SHOULDER)	H.H. SMITH	83330	2668	5
36	WASHER (SHOULDER)			2661	2
37	WASHER (NYLON)			2264-N-385	5
38	SOLDER LUG			1497	5
39	RETAINER	WALDS	79136	5305-31	1
40	SPRING	WAVETEK		B147-383	1
41	BRACKET, ROD			B162-310	1
42	BRACKET, CONN.			B162-311	1



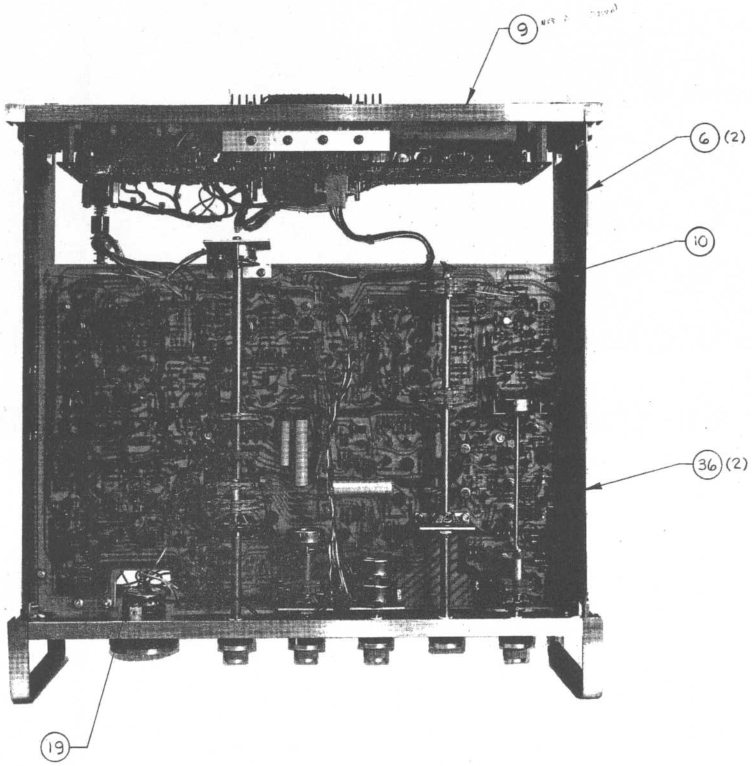
NOTE: BEFORE CLAMPING HANDLE CASTING IN PLACE, TRIM (TOP & BOTTOM) MUST BE IN PLACE

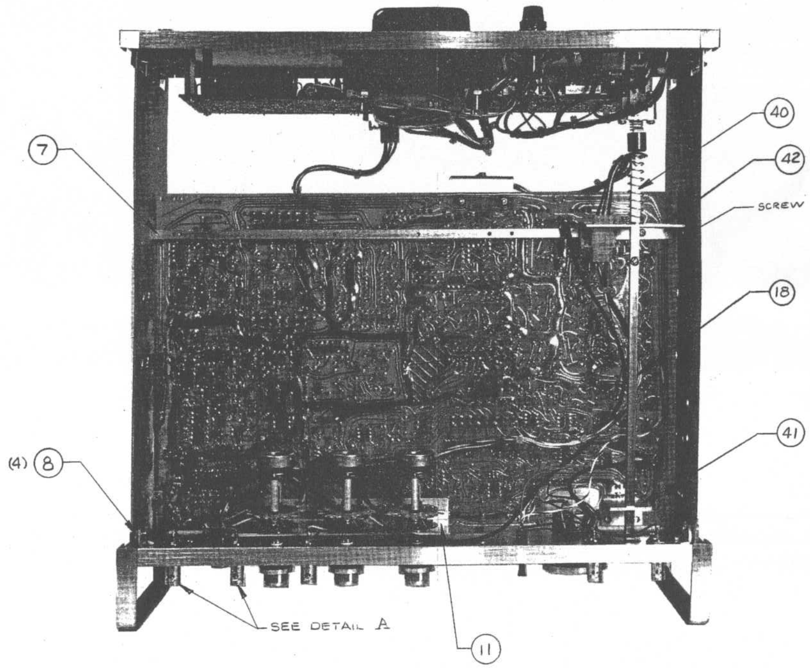
HANDLE DETAILS

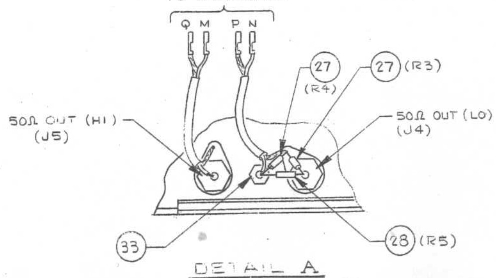
2. * INDICATES ITEMS NOT SHOWN.
1. FOR CHASSIS WIRING SEE CHASSIS SCHEMATIC D162-200.
NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN	DATE 3-1-74	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR Kwok Lo	4/10/74	TITLE ASSEMBLY, CHASSIS
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 .XX ±.030 ANGLES ±1		
	DO NOT SCALE DWG		MODEL NO. 162 — DWG NO. D162-000 — REV H
	SCALE NONE		CODE IDENT 23338 — SHEET 1 OF 3

REV	ECN	BY	DATE	APP



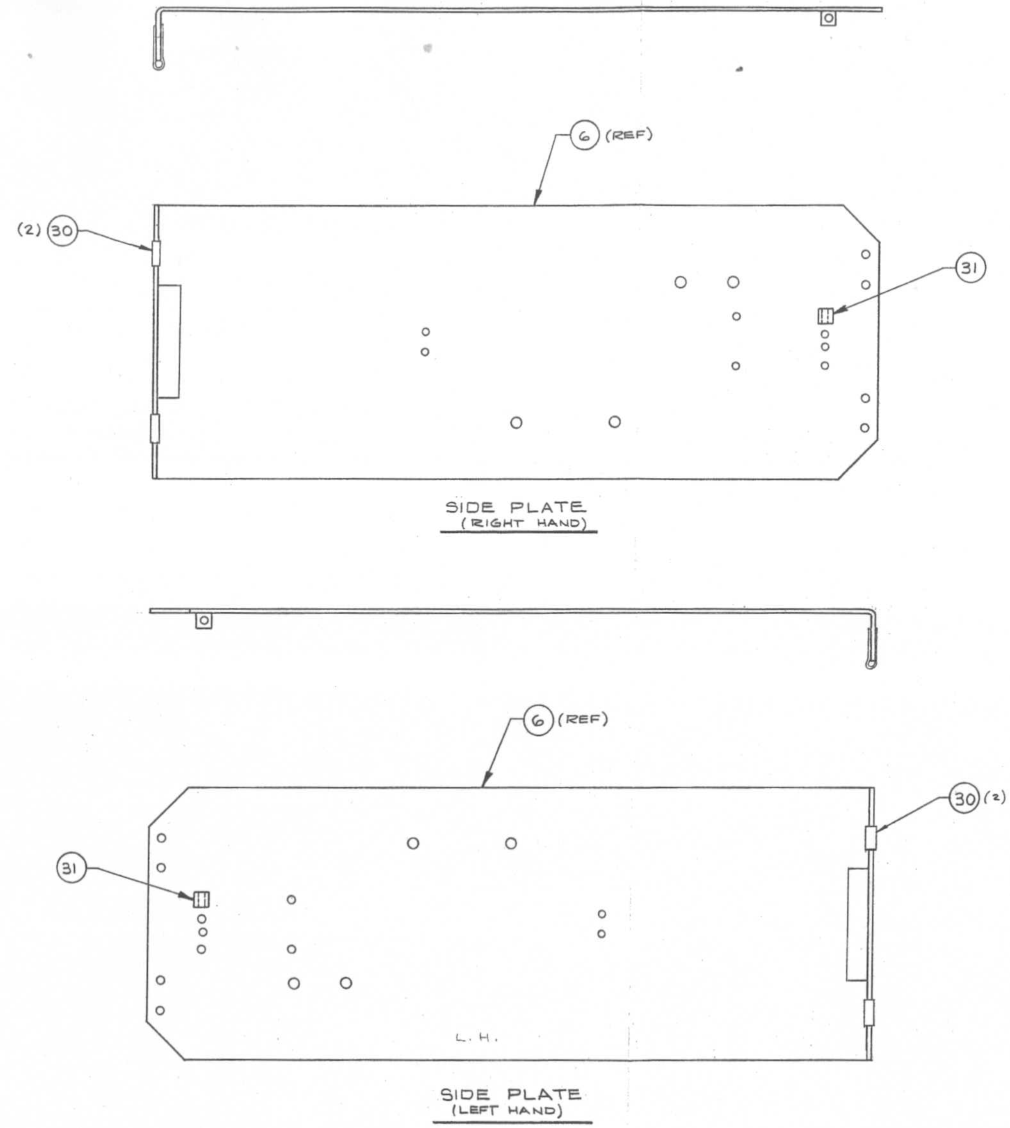




DETAIL A
CONNECTOR HOOK-UP

NOTE: UNLESS OTHERWISE SPECIFIED

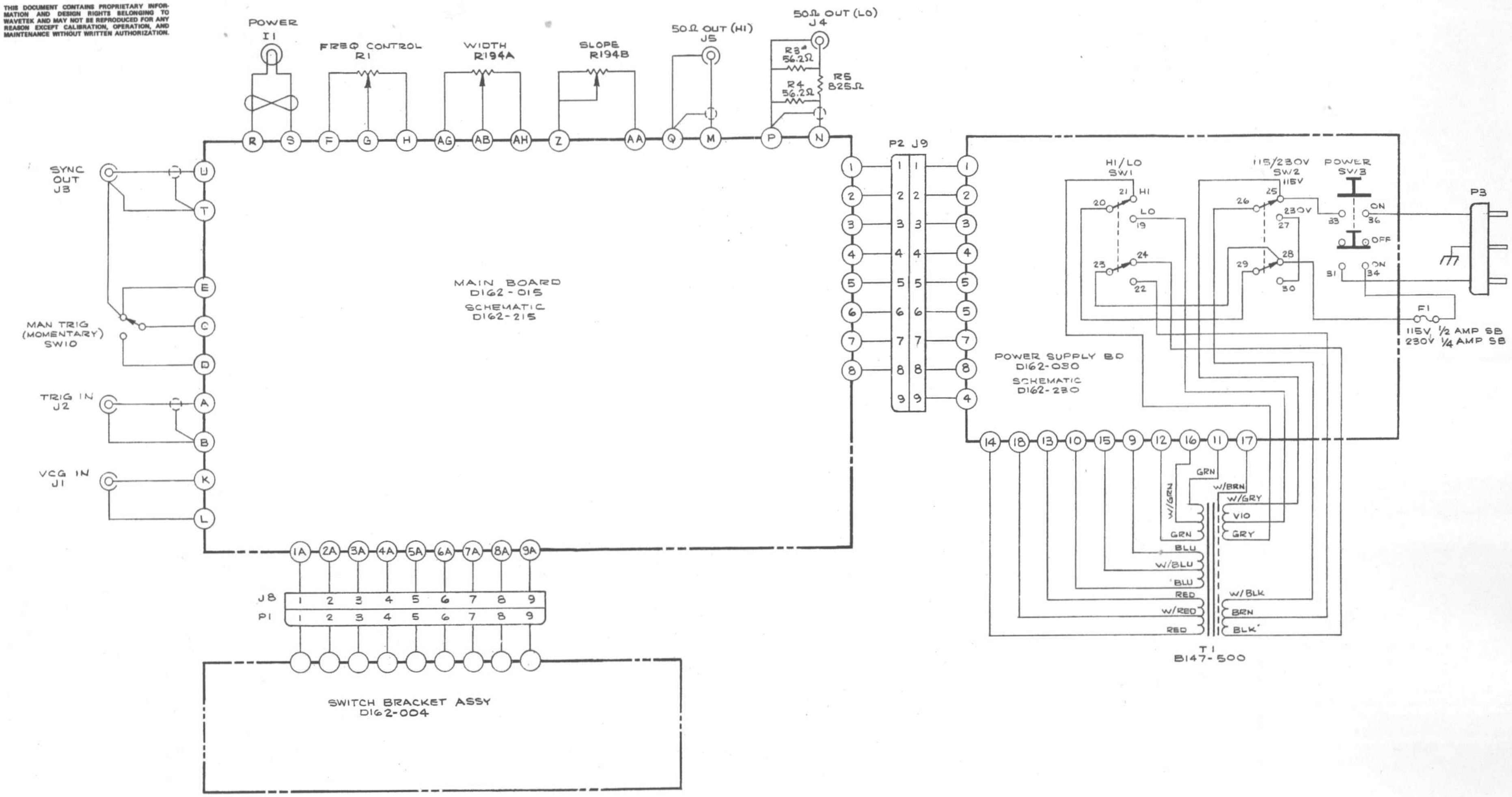
REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN	DATE 3-1-74	WAVETEK SAN DIEGO • CALIFORNIA	
MATERIAL	PROJ ENGR Kwok Lo	4/12/74	TITLE ASSEMBLY, CHASSIS	
	RELEASE APPROV			
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 ANGLES ±1 XX ±.030			
	DO NOT SCALE DWG		MODEL NO. 162	DWG NO. D162-000 REV H
	SCALE NONE		CODE IDENT 23338	SHEET 2 OF 3



INSERT INSTALLATION DETAIL

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN	DATE 3-1-74	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR Kwok Lo	4/12/74	TITLE ASSEMBLY, CHASSIS
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.030		
	DO NOT SCALE DWG		MODEL NO. 162 — DWG NO. D162-000 — REV H
	SCALE FULL		CODE IDENT 23338 — SHEET 3 OF 3

NOTE: UNLESS OTHERWISE SPECIFIED

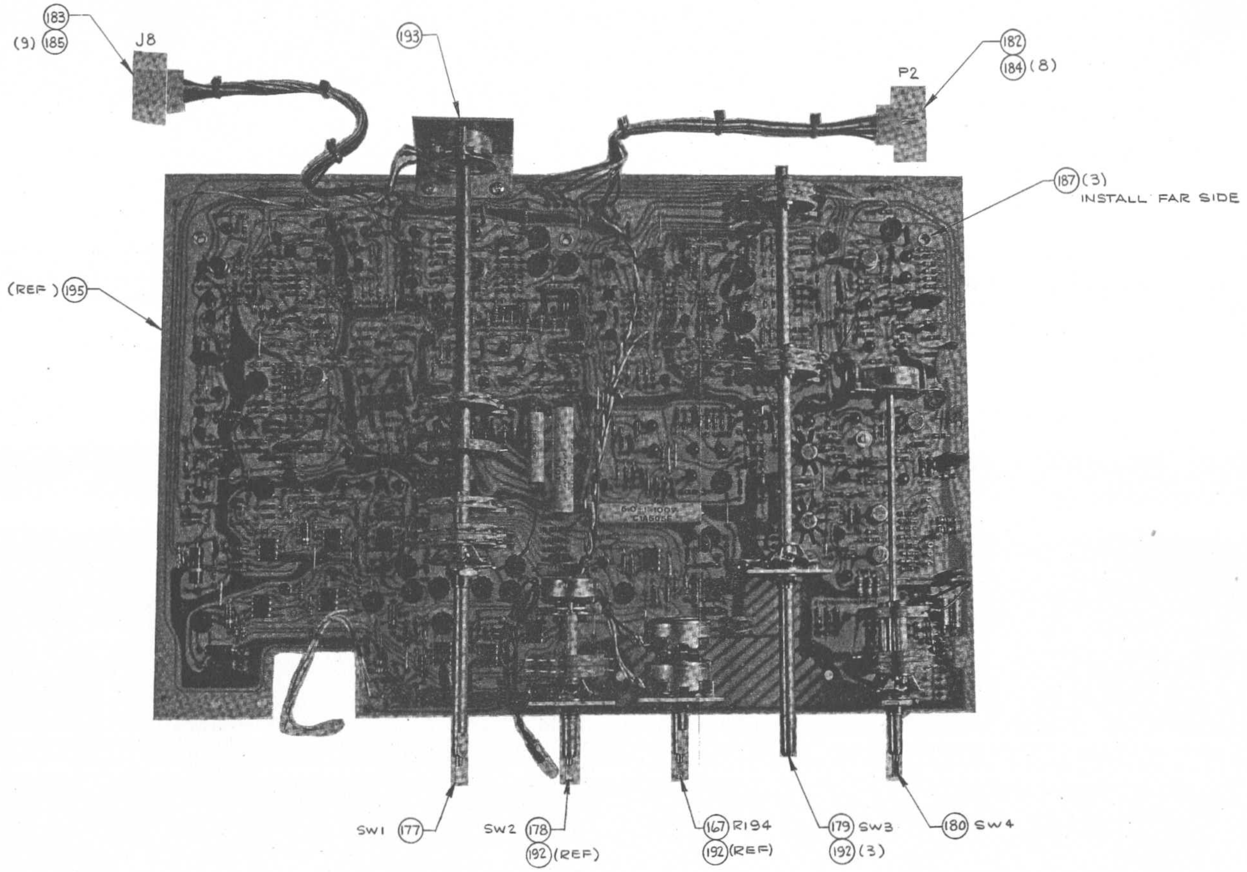


REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN	DATE 2-13-74	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR Kwok Fo	4-5-74	TITLE SCHEMATIC - CHASSIS
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.030		
	DO NOT SCALE DWG		MODEL NO. 162 / DWG NO. D162-200 / REV
	SCALE —//—		CODE IDENT 23338 / SHEET 1 OF 1

NOTE: UNLESS OTHERWISE SPECIFIED

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION, OPERATION, AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION.

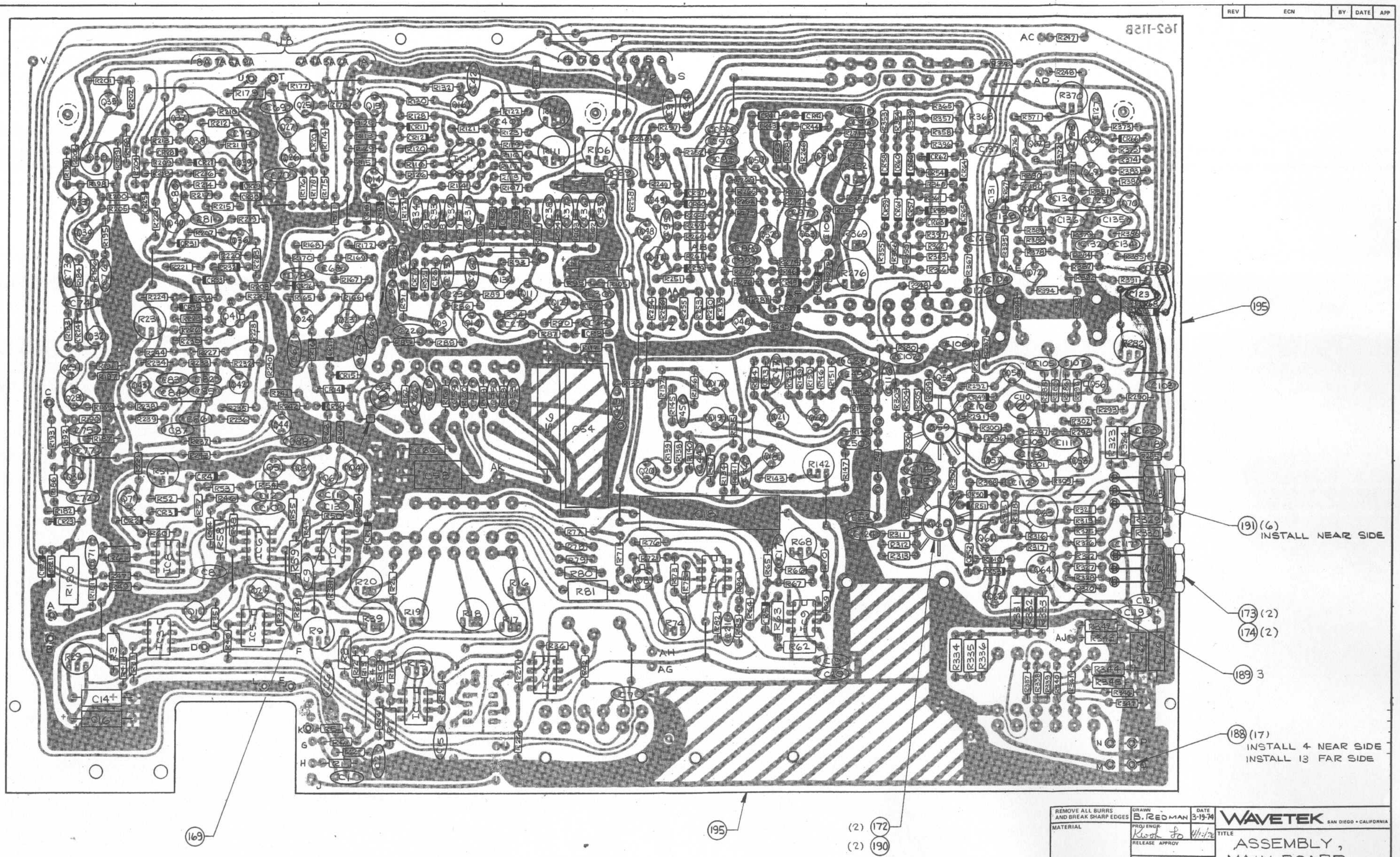
REV	ECN	BY	DATE	APP
D	ECN 904	DW		
E	ECN 1050			
F	ECN 1129			
G	ECN 1199			
H	ECN 1320	RO	7-7-75	
J	ECN 1324	R.	7-9-75	



NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN	DATE 3-19-74	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR		TITLE ASSEMBLY, MAIN BOARD
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.030		
	DO NOT SCALE DWG		MODEL NO. 162 / DWG NO. D162-015 / REV J
	SCALE		CODE IDENT 23338 / SHEET 1 OF 5

REV	ECN	BY	DATE	APP



NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES

MATERIAL

FINISH WAVETEK PROCESS

DRAWN B. REDMAN DATE 3-19-74

PROJ ENGR Kiraly Lo 4/1/74

RELEASE APPROV

TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 .XX ±.030 ANGLES ±1

DO NOT SCALE DWG

SCALE 2/1

WAVETEK SAN DIEGO • CALIFORNIA

TITLE ASSEMBLY, MAIN BOARD

MODEL NO. 162

DWG NO. D162-015

REV —

CODE IDENT 23338

SHEET 2 OF 5

REV	ECN	BY	DATE	APP

PARTS LIST

LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
1	Capacitors				
2	Ceramic Disc 1000V 5 pf	CRL	71590	DD-050	6
3	Ceramic Disc 1000V 10pf	CRL	71590	DD-100	6
4	Ceramic Disc 1000V 22pf	CRL	71590	DD-220	3
5	Ceramic Disc 1000V 33pf	CRL	71590	DD-330	2
6	Ceramic Disc 1000V 82pf	CRL	71590	DD-820	1
7	Ceramic Disc 1000V 100pf	CRL	71590	DD-101	2
8	Ceramic Disc 1000V 150pf	CRL	71590	DD-151	1
9	Ceramic Disc 1000V 220pf	CRL	71590	DD-221	4
10	Ceramic Disc 1000V 330pf	CRL	71590	DD-331	2
11	Ceramic Disc 1000V .001uf	CRL	71590	DD-102	8
12	CERAMIC DISC 1000V 16PF	CRL	71590	DD-150	1
13	Ceramic Disc 50V .01uf	CRL	71590	CK103	45
14	Ceramic Disc 50V .1uf	CRL	71590	CK104	2
15	Ceramic Disc 20V .1uf	CRL	71590	UK-20-104	25
16					
17					
18					
19	Silver Mica 500V 5% 15pf	Elmenco	72136	DM15-150J	1
20	Silver Mica 500V 5% 20pf	Elmenco	72136	DM15-200J	2
21	Silver Mica 500V 5% 30pf	Elmenco	72136	DM15-300J	2
22	Silver Mica 500V 5% 36pf	Elmenco	72136	DM15-360J	2
23	Silver Mica 500V 5% 82pf	Elmenco	72136	DM15-820J	1
24	Silver Mica 500V 5% 120pf	Elmenco	72136	DM15-121J	2
25	Silver Mica 500V 5% 150pf	Elmenco	72136	DM15-151J	1
26	Silver Mica 500V 1% 820pf	Elmenco	72136	DM15-821F	1
27	Silver Mica 500V 5% Trim	Elmenco	72136	DM15- J	2
28					
29					
30					
31	Electrolytic 5.6uf 35V	Sprague	56289	150D565X9035B2	6
32	Electrolytic 22uf 15V	Sprague	56289	96D226X9015KA1	1
33					
34					
35	Metal Polycarbon 5uf 1%	Elpac	12406	C1A505F	2
36	Metal Polycarbon 1uf 1%	Amer.Radionics	07994	210-BIC-105F	1
37	Metal Polycarbon .1uf 1%	Amer.Radionics	07994	PA2B104F	1
38	Metal Polycarbon .01uf 1%	Amer.Radionics	07994	PA2B103F	1
39					
40	Variable 3.5-13pf	Stetner		Stricko-3.5-13	1
41	Variable 7-35pf	Stetner		Stricko-7-35	1
42					
43					
44					
45	Diode FD777	Fairchild	33888	FD777	11
46	Diode FD6666	Fairchild	33888	FD6666	35
47	Diode HP2811	H/P		HP2811	2
48	Diode Zener 1N4581	Motorola	04713	1N4581	5
49	Diode Tunnel 1N3716	Motorola	04713	1N3716	1
50	Diode Matched Set (-93)	Fairchild	33888	FD777	1set
51	Diode Matched Set (-56)	Fairchild	33888	HP5082-2811	1set
52					
53					
54	Integrated Circuit CA3049	RCA	86684	CA3049	1
55	Integrated Circuit LM741C	National	27014	LM741C	9
56					
57					
58					

PARTS LIST

LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
59	Transistor 2N2219A	Motorola	04713	2N2219A	2
60	Transistor 2N2905A	Fairchild	33888	2N3905A	1
61	Transistor 2N3563	Fairchild	33888	2N3563	4
62	Transistor 2N3640	Fairchild	33888	2N3640	11
63	Transistor 2N3646	Fairchild	33888	2N3646	15
64	Transistor 2N3866	Motorola	04713	2N3866	2
65	Transistor 2N3903	Fairchild	33888	2N3903	3
66	Transistor 2N5139	Fairchild	33888	2N5139	16
67	Transistor 2N5160	Fairchild	33888	2N5160	2
68	Transistor 2N5462	National	27014	2N5462	3
69	Transistor 2N5485	Motorola	04713	2N5485	2
70	TP308	Technical Products		TP308	1
71	AD812			AD812	3
72	Transistor Matched Set(-52)	Fairchild	33888	2N3563	1set
73	Transistor Matched Set(-88)	Fairchild	33888	2N5139	1set
74	Transistor Matched set(-53)	Motorola	04713	2N5485	1set
75	TRANSISTOR	FCHLD	33888	2N2903	1
76					
77					
78	Resistors				
79	Metal Film 1/8W 1% 10Ω	Corning	16299	RN55D	23
80	Metal Film 1/8W 1% 15Ω	Corning	16299	RN55D	9
81	Metal Film 1/8W 1% 21.5Ω	Corning	16299	RN55D	7
82	Metal Film 1/8W 1% 27.4Ω	Corning	16299	RN55D	3
83	Metal Film 1/8W 1% 33.2Ω	Corning	16299	RN55D	23
84	Metal Film 1/8W 1% 46.4Ω	Corning	16299	RN55D	1
85	Metal Film 1/8W 1% 51.1Ω	Corning	16299	RN55D	1
86	Metal Film 1/8W 1% 59Ω	Corning	16299	RN55D	1
87	Metal Film 1/8W 1% 61.9Ω	Corning	16299	RN55D	5
88	Metal Film 1/8W 1% 68.1Ω	Corning	16299	RN55D	5
89	Metal Film 1/8W 1% 90.9Ω	Corning	16299	RN55D	2
90	Metal Film 1/8W 1% 100Ω	Corning	16299	RN55D	27
91	Metal Film 1/8W 1% 124Ω	Corning	16299	RN55D	2
92	Metal Film 1/8W 1% 150Ω	Corning	16299	RN55D	7
93	Metal Film 1/8W 1% 165Ω	Corning	16299	RN55D	1
94	Metal Film 1/8W 1% 215Ω	Corning	16299	RN55D	1
95	Metal Film 1/8W 1%82.5Ω	Corning	16299	RN55D	1
96	Metal Film 1/8W 1% 249Ω	Corning	16299	RN55D	19
97	METAL FILM 1/8W 1% 301Ω	CORNING	16299	RN55D	2
98	Metal Film 1/8W 1% 316Ω	Corning	16299	RN55D	7
99	Metal Film 1/8W 1% 332Ω	Corning	16299	RN55D	2
100	Metal Film 1/8W 1% 392Ω	Corning	16299	RN55D	3
101	Metal Film 1/8W 1% 464Ω	Corning	16299	RN55D	2
102	Metal Film 1/8W 1% 499Ω	Corning	16299	RN55D	9
103	Metal Film 1/8W 1% 681Ω	Corning	16299	RN55D	1
104	Metal Film 1/8W 1% 750Ω	Corning	16299	RN55D	10
105	Metal Film 1/8W 1% 825Ω	Corning	16299	RN55D	5
106	Metal Film 1/8W 1% 909Ω	Corning	16299	RN55D	1
107	Metal Film 1/8W 1% 1K	Corning	16299	RN55D	23
108	Metal Film 1/8W 1% 1.1K	Corning	16299	RN55D	4
109	Metal Film 1/8W 1% 1.21K	Corning	16299	RN55D	4
110	Metal Film 1/8W 1% 1.5K	Corning	16299	RN55D	17
111	Metal Film 1/8W 1% 1.78K	Corning	16299	RN55D	3
112	Metal Film 1/8W 1% 1.96K	Corning	16299	RN55D	1
113	Metal Film 1/8W 1% 2K	Corning	16299	RN55D	8
114	Metal Film 1/8W 1% 2.49K	Corning	16299	RN55D	15
115	Metal Film 1/8W 1% 3.01K	Corning	16299	RN55D	3
116	Metal Film 1/8W 1% 3.32K	Corning	16299	RN55D	3

PARTS LIST

LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
117	Metal Film 1/8W 1% 3.65K	Corning	16299	RN55D	6
118	Metal Film 1/8W 1% 4.02K	Corning	16299	RN55D	1
119	Metal Film 1/8W 1% 4.99K	Corning	16299	RN55D	8
120	Metal Film 1/8W 1% 6.98K	Corning	16299	RN55D	1
121	Metal Film 1/8W 1% 7.5K	Corning	16299	RN55D	19
122	Metal Film 1/8W 1% 9.09K	Corning	16299	RN55D	1
123	Metal Film 1/8W 1% 10K	Corning	16299	RN55D	14
124	Metal Film 1/8W 1% 15K	Corning	16299	RN55D	8
125	Metal Film 1/8W 1% 24.9K	Corning	16299	RN55D	3
126	Metal Film 1/8W 1% 30.1K	Corning	16299	RN55D	1
127					
128	Metal Film 1/8W 1% 49.9K	Corning	16299	RN55D	1
129	Metal Film 1/8W 1% 21.5K	Corning	16299	RN55D	1
130	Metal Film 1/8W 1% 15K	Corning	16299	RN55D	1
131	Metal Film 1/8W 1% 301K	Corning	16299	RN55D	3
132	Metal Film 1/8W 1% 47.5K	Corning	16299	RN55D	1
133	Metal Film 1/8W 1% Trim	Corning	16299	RN55D	3
134	Metal Film 1/8w 1% 69.8K	Corning	16299	RN55D	1
135	" " " " 2.74K	"	"	"	1
136					
137	Metal Film 1/4W 1% 49.9Ω	Corning	16299	RN60D	1
138	Metal Film 1/4W 1% 75Ω	Corning	16299	RN60D	6
139	Metal Film 1/4W 1% 196Ω	Corning	16299	RN60D	4
140	Metal Film 1/4W 1% 1M				1
141					
142					
143	Carbon 1/2W 5% 10Ω	Stackpole	29604	RC20GF	4
144	Carbon 1/2W 5% 2.2M	Stackpole	29604	RC20GF	2

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN	DATE 3-4-74	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR Kirk Lo	4/12/74	TITLE ASSEMBLY, MAIN BOARD
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.030		
	DO NOT SCALE DWG		MODEL NO. 162 / DWG NO. B162-015 / REV. J
	SCALE NONE		CODE IDENT 23338 / SHEET 3 OF 5

REV	ECN	BY	DATE	APP

PARTS LIST

LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
145	Carbon 1/2W 5% 6.8M	Stackpole	29604	RC20GF	3
146	Carbon 1/2W 5% 10M	Stackpole	29604	RC20GF	1
147					
148					
149	Carbon 1W 5% 10K	Stackpole	29604	RC32GF	1
150					
151	1% 10M	Caddock	19647	ML-181	1
152					
153	Matched Set (-89)				1set
154	Matched Set 1K	Corning	16299	RN55D	Ref
155	Matched Set 10K	Corning	16299	RN55D	Ref
156	Matched Set 100K	Corning	16299	RN55D	Ref
157	Matched Set 1M	Corning	16299	RN55D	Ref
158					
159					
160	Potentiometer 20Ω	Beckman	80740	91AR20	1
161	Potentiometer 100Ω	Beckman	80740	91AR100	1
162	Potentiometer 200Ω	Beckman	80740	91AR200	1
163	Potentiometer 500Ω	Beckman	80740	91AR500	13
164	Potentiometer 5K	Beckman	80740	91AR5K	1
165	Potentiometer 10K	Beckman	80740	91AR10K	2
166	Potentiometer 100K	Beckman	80740	91AR100K	4
167	Potentiometer 10K (Dual)	Wavetek	23338	B162-402	1
168					
169	Ferrite Bead	Ferroxcube	02114	56-590-65/3B	1
170	LAMP	MURA		L28/40	1
171					
172	Heat Sink	Wakefield	05820	NF-207	2
173	Heat Sink	Thermolly	1303	1103A	2
174	Heat Sink	Thermolly	1303	1103B	2
175					
176					
177	Switch Assy	Wavetek	23338	D162-020	1
178	Switch Assy	Wavetek	23338	D162-021	1
179	Switch Assy	Wavetek	23338	D162-022	1
180	Switch Assy	Wavetek	23338	D162-023	1
181					
182	Connector, Plug	Molex	27264	03-06-2091	1
183	Connector, Receptacle	Molex	27264	03-06-1091	1
184	Pins, Male	Molex	27264	02-06-2103	8
185	Pins, Female	Molex	27264	02-06-1103	9
186					
187	Standoff	Lyntron	07591	6310-4-2C	3
188	Amp Pins	AMP	00779	61182-2	17
189	Transipads	Milton Ross	07047	10123N	3
190	Transipads (Tall)	Milton Ross	07047	10160	2
191	Terminal	USECO	88245	2005B-1	6
192	Bracket	Wavetek	23338	B133-305	3
193	Bracket	Wavetek	23338	B162-303	1
194					
195	Circuit Board	Wavetek	23338	162-115B	1
196	Schematic	Wavetek	23338	D162-215	Ref

NOTE: UNLESS OTHERWISE SPECIFIED

LINE ITEM REFERENCE LIST

REF DES	P/L LINE	REF DES	P/L LINE	REF DES	P/L LINE
C1	13	C56	36	C111	13
C2	13	C57	25	C112	2
		C58	37	C113	13
C4	8	C59	22	C114	15
		C60	38	C115	15
C6	15	C61	23	C116	13
C7	11	C62	26	C117	4
C8	14	C63	5	C118	15
C9	14	C64	41	C119	15
C10	11	C65	22	C120	31
C11	11	C66	15	C121	15
C12	10	C67	15	C122	31
C13	10	C68	13	C123	15
C14	31	C69	13	C124	13
C15	15	C70	13	C125	4
C16	31	C71	5	C126	4
C17	11	C72	13	C127	13
C18	35	C73	7	C128	3
C19	15	C74	15	C129	13
C20	15	C75	32	C130	13
C21	13	C76	6	C131	15
C22	19	C77	13	C132	2
C23	7	C78	13	C133	12
C24	13	C79	13	C134	2
C25	13	C80	11	C135	15
C26	9	C81	3	C136	15
C27	9	C82	13	C137	15
C28	13	C83	13	C138	13
C29	15	C84	2		
C30	13	C85	2	CR1	46
C31	27	C86	15	CR2	46
C32	21	C87	15	CR3	46
C33	20	C88	15	CR4	50
C34	24	C89	13	CR5	46
C35	24	C90	13	CR6	48
C36	20	C91	13	CR7	48
C37	21	C92	13	CR8	48
C38	27	C93	13	CR9	47
C39	15	C94	13	CR10	47
C40	13	C95	9	CR11	46
C41	13	C96	13	CR12	46
C42	13	C97	9	CR13	48
C43	2	C98	13	CR14	45
C44	13	C99	15	CR15	45
C45	2	C100	13	CR16	45
C46	13	C101	15	CR17	45
C47	11	C102	3	CR18	46
C48	31	C103	13	CR19	46
C49	13	C104	13	CR20	46
C50	13	C105	3	CR21	46
C51	31	C106	13	CR22	46
C52	15	C107	3	CR23	46
C53	11	C108	13	CR24	49
C54	35	C109	13	CR25	46
C55	11	C110	40	CR26	46

LINE ITEM REFERENCE LIST

REF DES	P/L LINE	REF DES	P/L LINE	REF DES	P/L LINE
CR27	46	Q1	69	Q55	66
CR28	46	Q2	68	Q56	71
CR29	46	Q3	68	Q57	61
CR30	46	Q4	69	Q58	62
CR31	46	Q5	66	Q59	67
CR32	45	Q6	63	Q60	64
CR33	46	Q7	68	Q61	63
CR34	46	Q8	70	Q62	62
CR35	46	Q9	74	Q63	59
CR36	50	Q10	74	Q64	60
CR37	46	Q11	73	Q65	64
CR38	46	Q12	73	Q66	67
CR39	46	Q13	61	Q67	71
CR40	46	Q14	62	Q68	66
CR41	45	Q15	62	Q69	66
CR42	45	Q16	66	Q70	62
CR43	46	Q17	72	Q71	61
CR44	46	Q18	62	Q72	62
CR45	45	Q19	72		
CR46	45	Q20	63	R1	84
CR47	45	Q21	61	R2	131
CR48	45	Q22	66	R3	177
CR49	46	Q23	63		
CR50	46	Q24	66	R5	119
CR51	46	Q25	66	R6	124
CR52	46	Q26	63	R7	140
CR53	46	Q27	66	R8	144
CR54	51	Q28	65	R9	166
CR55	51	Q29	65	R10	129
CR56	51	Q30	59	R11	117
CR57	51	Q31	66	R12	133
CR58	51	Q32	62	R13	120
CR59	51	Q33	62	R14	119
CR60	51	Q34	63	R15	165
CR61	51	Q35	66	R16	163
CR62	51	Q36	66	R17	163
CR63	51	Q37	63	R18	163
CR64	51	Q38	63	R19	163
CR65	51	Q39	63	R20	163
CR66	46	Q40	66	R21	96
CR67	48	Q41	71	R22	110
CR68	46	Q42	62		
IC1	55	Q43	63		
		Q44	66		
IC3	55	Q45	63	R26	119
IC4	55	Q46	63	R27	119
IC5	55	Q47	63		
IC6	55	Q48	65	R29	166
IC7	55	Q49	63	R30	145
IC8	55	Q50	66	R31	113
IC9	55	Q51	75	R32	113
IC10	55	Q52	63		
IC11	54	Q53	62		
		Q54	66	R33	110

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMANN	DATE 4-12-74	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR Kwok Lo	4/12/74	TITLE ASSEMBLY MAIN BOARD
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 .XX ±.030 ANGLES ±1°		
	DO NOT SCALE DWG		MODEL NO. 162 / DWG NO. B162-015 / REV J
	SCALE NONE		CODE IDENT 23338 / SHEET 4 OF 5

REV	ECN	BY	DATE	APP

LINE ITEM REFERENCE LIST

REF DES	P/L LINE	REF DES	P/L LINE	REF DES	P/L LINE
R36	113	R91	110	R145	90
R37	110	R92	110	R146	121
R38	112	R93	92	R147	79
R39	161	R94	83	R148	83
R40	107	R95	104	R149	96
R41	107	R96	79	R150	121
R42	122	R97	80	R151	79
R43	178	R98	96	R152	83
R44	113	R99	110	R153	105
R45	110	R100	98	R154	131
R46	104	R101	98	R155	79
R47	79	R102	110	R156	90
R48	110	R103	96	R157	124
R49	79	R104	80	R158	90
R50	100	R105	79	R159	90
R51	160	R106	163	R160	90
R52	79	R107	116	R161	90
R53	91	R108	98	R162	80
R54	100	R109	98	R163	83
R55	96	R110	116	R164	83
R56	96	R111	163	R165	121
R57	102	R112	83	R166	121
R58	145	R113	107	R167	83
R59	145	R114	101	R168	83
R60	110	R115	109	R169	117
R61	104	R116	83	R170	117
R62	146	R117	107	R171	79
R63	144	R118	83	R172	79
R64	123	R119	123	R173	90
R65	123	R120	96	R174	90
R66	133	R121	83	R175	114
R67	132	R122	107	R176	102
R68	164	R123	109	R177	107
R69	90	R124	163	R178	102
R70	79	R125	109	R179	137
R71	96	R126	83	R180	149
R72	90	R127	92	R181	90
R73	124	R128	100	R182	124
R74	162	R129	107	R183	107
R75	124	R130	107	R184	95
R76	107	R131	110	R185	111
R77	154	R132	79	R186	121
R78	155	R133	83	R187	50
R79	156	R134	119	R188	115
R80	157	R135	90	R189	113
R81	151	R136	88	R190	107
R82	85	R137	90	R191	107
R83	101	R138	121	R192	123
R84	89	R139	98	R193	102
R85	79	R140	104	R194	167
R86	98	R141	83	R195	119
R87	98	R142	163	R196	90
R88	83	R143	106	R197	123
R89	83	R144	90	R198	123
R90	83				

LINE ITEM REFERENCE LIST

REF DES	P/L LINE	REF DES	P/L LINE	REF DES	P/L LINE
R199	123	R253	79	R307	79
R200	121	R254	79	R308	81
R201	123	R255	114	R309	110
R202	119	R256	114	R310	79
R203	114	R257	113	R311	107
R204	104	R258	104	R312	107
R205	90	R259	88	R313	107
R206	102	R260	109	R314	82
R207	123	R261	123	R315	125
R208	90	R262	88	R316	108
R209	121	R263	90	R317	108
R210	104	R264	135	R318	125
R211	110	R265	102	R319	90
R212	110	R266	102	R320	90
R213	117	R267	104	R321	87
R214	90	R268	111	R322	87
R215	92	R269	114	R323	143
R216	115	R270	121	R324	143
R217	107	R271	114	R325	80
R218	121	R272	90	R326	80
R219	121	R273	107	R327	80
R220	114	R274	81	R328	80
R221	114	R275	107	R329	143
R222	102	R276	134	R330	143
R223	90	R277	117	R331	138
R224	119	R278	116	R332	138
R225	107	R279	163	R333	138
R226	114	R280	96	R334	138
R227	128	R281	90	R335	138
R228	90	R282	166	R336	138
R229	107	R283	180	R337	82
R230	96	R284	83	R338	91
R231	165	R285	79	R339	93
R232	121	R286	130	R340	96
R233	124	R287	110	R341	105
R234	121	R288	96	R342	139
R235	107	R289	94	R343	139
R236	81	R290	110	R344	139
R237	104	R291	114	R345	139
R238	111	R292	114	R346	87
R239	81	R293	118	R347	86
R240	114	R294	107	R348	79
R241	79	R295	79	R349	113
R242	79	R296	121	R350	113
R243	90	R297	126	R351	103
R244	125	R298	121	R352	163
R245	88	R299	104	R353	124
R246	88	R300	83	R354	123
R247	80	R301	115	R355	124
R248	80	R302	83	R356	123
R249	96	R303	105	R357	96
R250	96	R304	105	R358	92
R251	96	R305	105		
R252	96	R306	82	R360	108

LINE ITEM REFERENCE LIST

REF DES	P/L LINE	REF DES	P/L LINE	REF DES	P/L LINE
R361	108				
R362	92				
R363	96				
R365	121				
R366	121				
R367	87				
R368	163				
R369	163				
R370	166				
R371	131				
R372	107				
R373	83				
R374	114				
R375	114				
R376	117				
R377	102				
R378	87				
R379	83				
R380	121				
R381	123				
R382	121				
R383	96				
R384	97				
R385	110				
R386	81				
R387	97				
R388	83				
R389	81				
R390	114				
R391	99				
R392	99				
R393	89				
R394	79				
R395	81				
R396	92				
R397	92				
R398	123				
SW1	177				
SW2	178				
SW3	179				
SW4	180				

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN	DATE 3-5-74	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR Lorok Lo	4/14/74	TITLE ASSEMBLY, MAIN BOARD
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 .XX ±.030 ANGLES ±1°		
	DO NOT SCALE DWG		MODEL NO. 162 / DWG NO. B162-015 / REV J
	SCALE NONE		CODE IDENT 23338 / SHEET 5 OF 5

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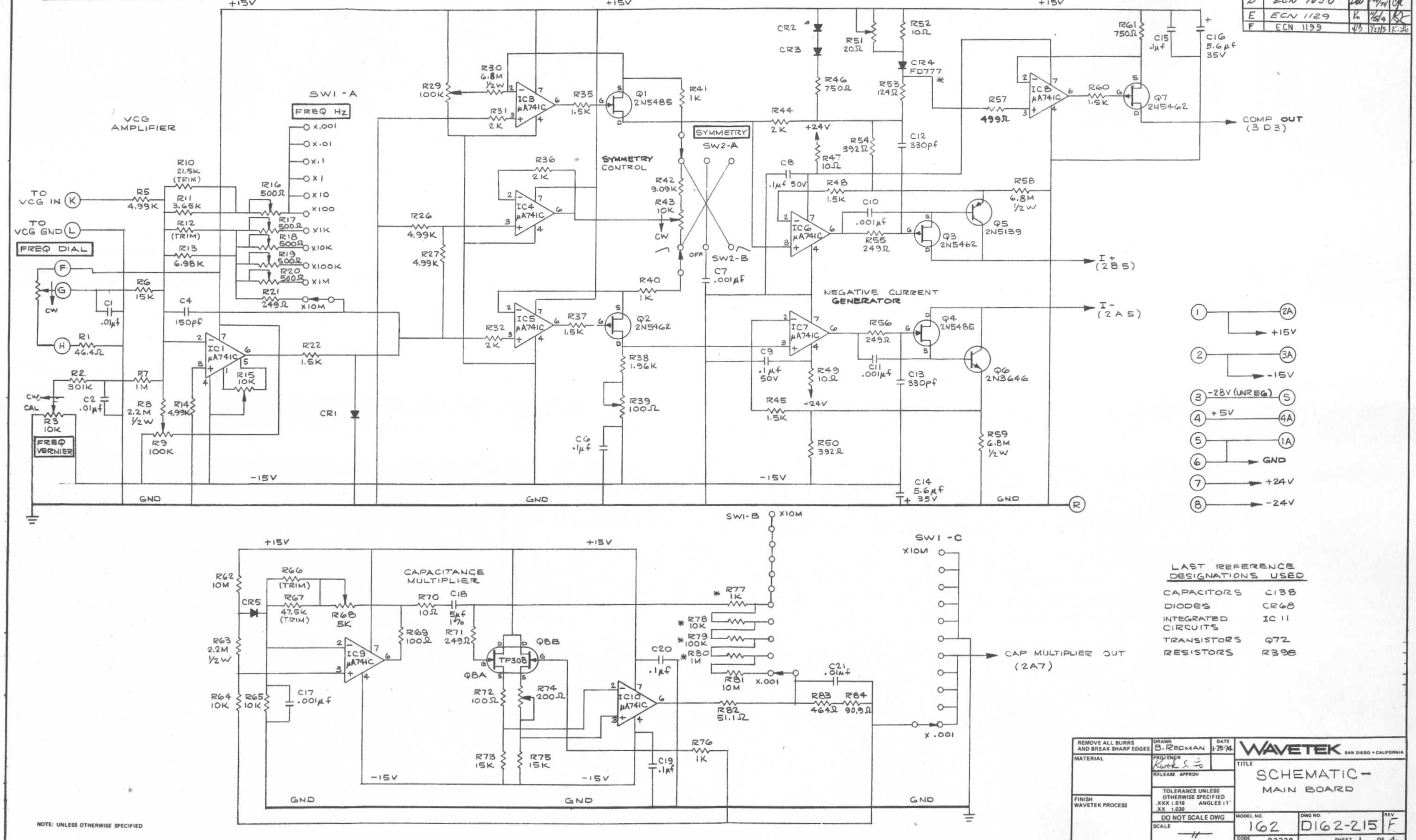
REV	ECN	BY	DATE	APP
B	ECN 980			
C	ECN 1049			
D	ECN 1050			
E	ECN 1129			
F	ECN 1199			



LAST REFERENCE DESIGNATIONS USED

CAPACITORS	C138
DIODES	CR68
INTEGRATED CIRCUITS	IC 11
TRANSISTORS	Q72
RESISTORS	R398

NOTE: UNLESS OTHERWISE SPECIFIED

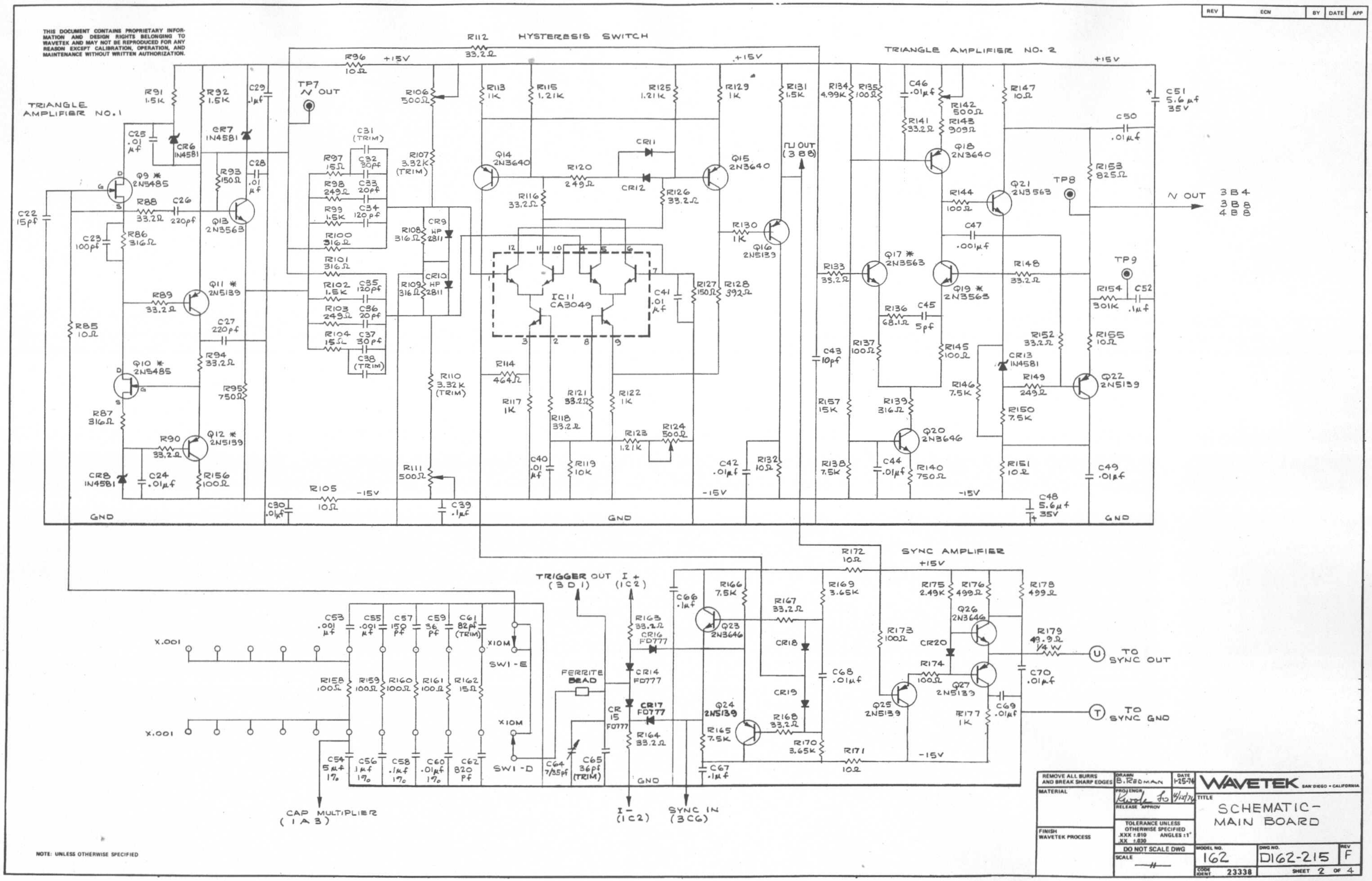
REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN DATE 1-25-74
MATERIAL	PROJ ENGR
	RELEASE APPROV
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.030
	DO NOT SCALE DWG
	SCALE

WAVETEK SAN DIEGO • CALIFORNIA

TITLE SCHEMATIC - MAIN BOARD

MODEL NO. 162 DWG NO. D162-215 REV F

CODE IDENT 23338 SHEET 1 OF 4



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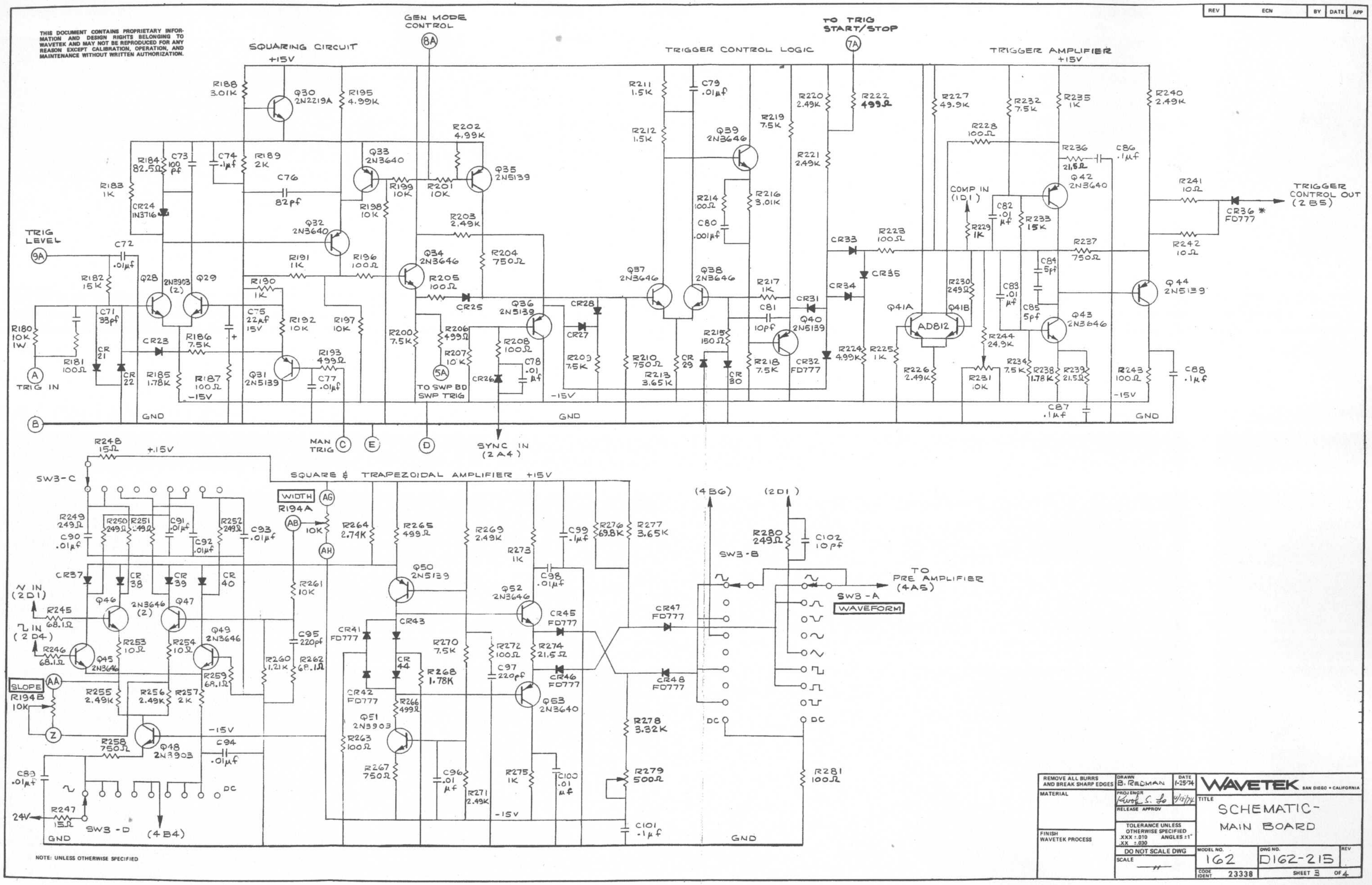
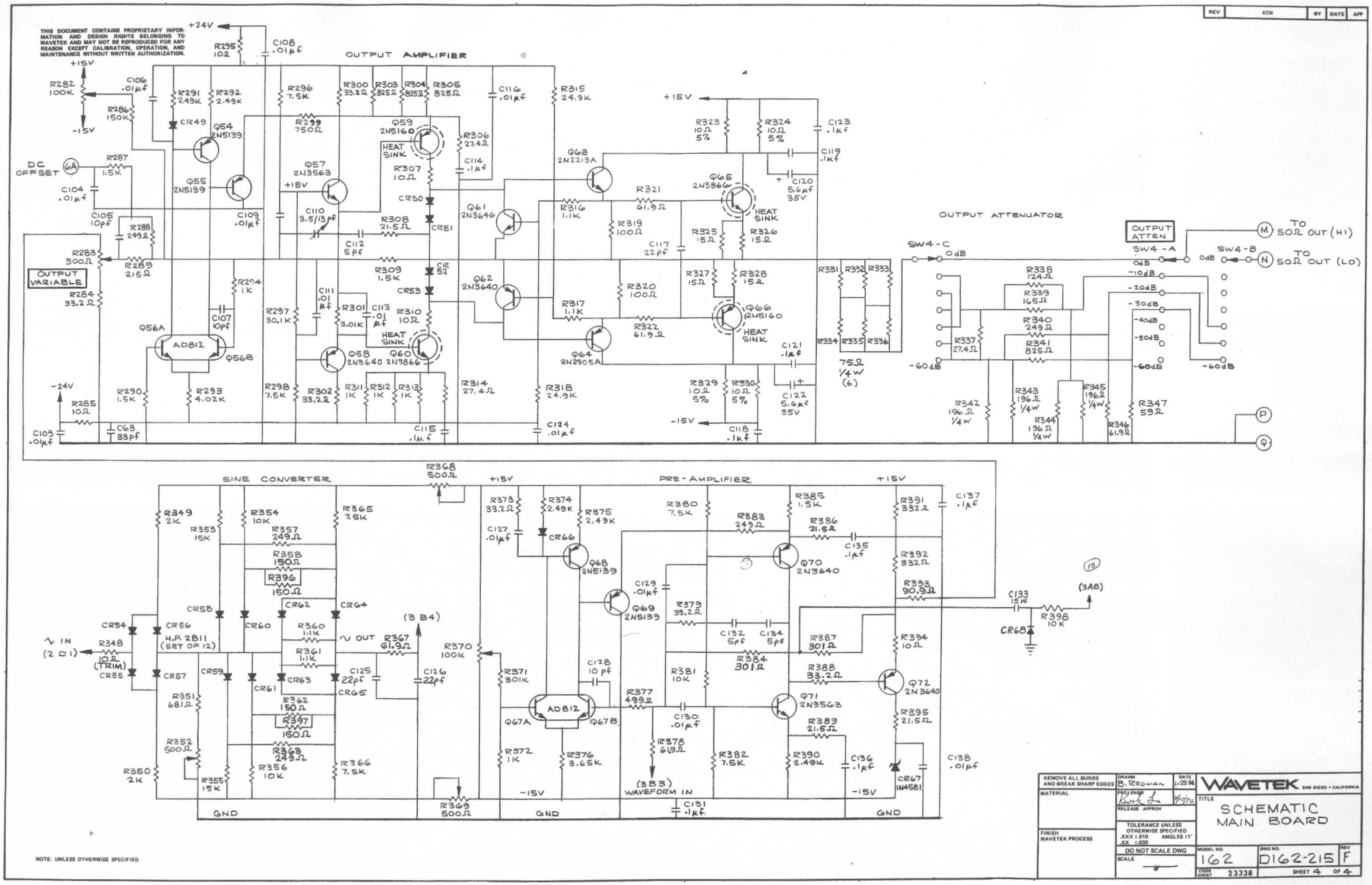
REV
ECN
BY
DATE
APP
HYSTERESIS SWITCH
TRIANGLE AMPLIFIER NO. 1
TRIANGLE AMPLIFIER NO. 2
TP7
OUT
TP8
TP9
OUT 3B4 3B8 4B8
⊓ OUT (3B8)
IC11 CA3049
GND
+15V
-15V
SYNC AMPLIFIER
TRIGGER OUT (3D1)
I+ (1C2)
I- (1C2)
SYNC IN (3C6)
CAP MULTIPLIER (1A3)
FERRITE BEAD
SW1-E
SW1-D
X10M
X.001
TO SYNC OUT
TO SYNC GND
NOTE: UNLESS OTHERWISE SPECIFIED
REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS
DRAWN B. REDMAN
DATE 1-25-74
PROJ ENGR
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.030
DO NOT SCALE DWG
SCALE
WAVETEK SAN DIEGO • CALIFORNIA
TITLE
SCHEMATIC-MAIN BOARD
MODEL NO. 162
DWG NO. D162-215
REV F
CODE IDENT 23338
SHEET 2 OF 4


SQUARING CIRCUIT
GEN MODE CONTROL
TRIGGER CONTROL LOGIC
TO TRIG START/STOP
TRIGGER AMPLIFIER
TRIG LEVEL
TRIG IN
TRIGGER CONTROL OUT (2B5)
COMP IN (1D1)
TO SWP BD SWP TRIG
MAN TRIG
SYNC IN (2A4)
SQUARE & TRAPEZOIDAL AMPLIFIER +15V
WIDTH R194A
SLOPE R194B
TO PRE AMPLIFIER (4A5)
SW3-A WAVEFORM
SW3-B
SW3-C
SW3-D
(4B6)
(2D1)
(4B4)
GND
NOTE: UNLESS OTHERWISE SPECIFIED
REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS
DRAWN B. REDMAN
DATE 1-25-74
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.030
DO NOT SCALE DWG
SCALE
WAVETEK SAN DIEGO • CALIFORNIA
TITLE SCHEMATIC- MAIN BOARD
MODEL NO. 162
DWG NO. D162-215
CODE IDENT 23338
SHEET 3 OF 4
REV ECN BY DATE APP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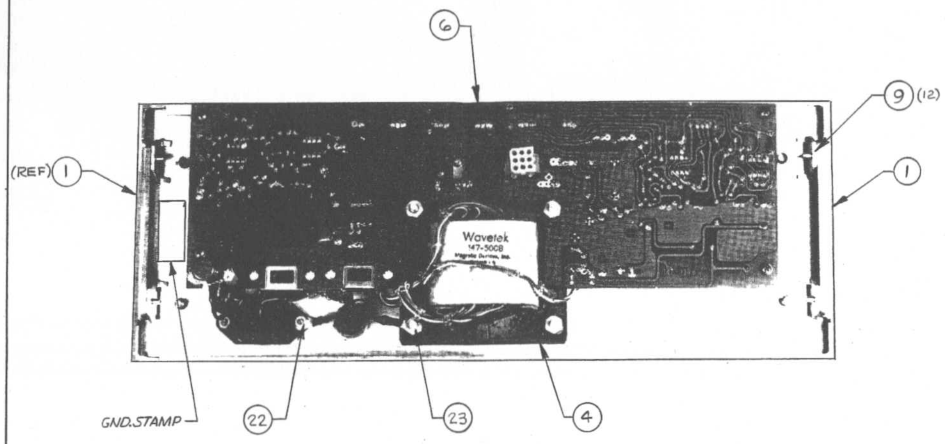
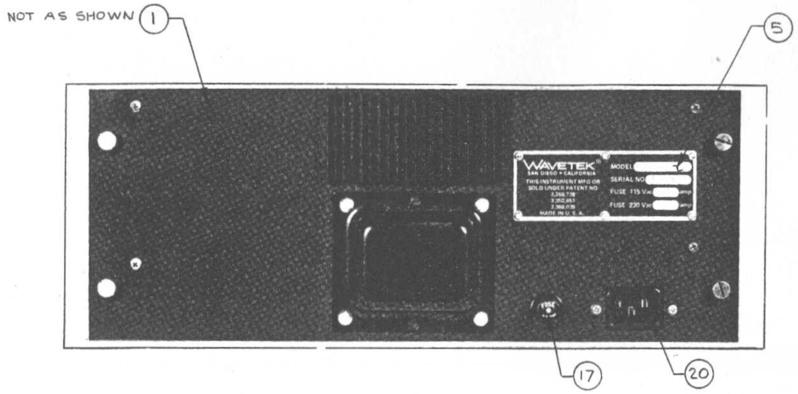
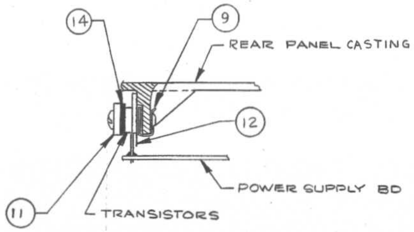
OUTPUT AMPLIFIER
DC OFFSET
OUTPUT VARIABLE
HEAT SINK
OUTPUT ATTENUATOR
OUTPUT ATTEN
TO 50Ω OUT (HI)
TO 50Ω OUT (LO)
SINE CONVERTER
PRE-AMPLIFIER
∿ IN (2 D1)
∿ OUT
(3 B4)
(3B3) WAVEFORM IN
(3A8)
H.P. 2811 (SET OF 12)
GND
NOTE: UNLESS OTHERWISE SPECIFIED
REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS
DRAWN B. REDMAN
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 .XX ±.030 ANGLES ±1°
DO NOT SCALE DWG
SCALE
WAVETEK SAN DIEGO • CALIFORNIA
TITLE SCHEMATIC MAIN BOARD
MODEL NO. 162
DWG NO. D162-215
REV F
CODE IDENT 23338
SHEET 4 OF 4

REV	ECN	BY	DATE	APP
B	ECN 1052	Ro	10/1/74	
C	ECN 1324	Ru	7-10-5	
D	DDC #1464	DC	9-16-6	







TRANSISTOR CLAMP DETAILS

PARTS LIST

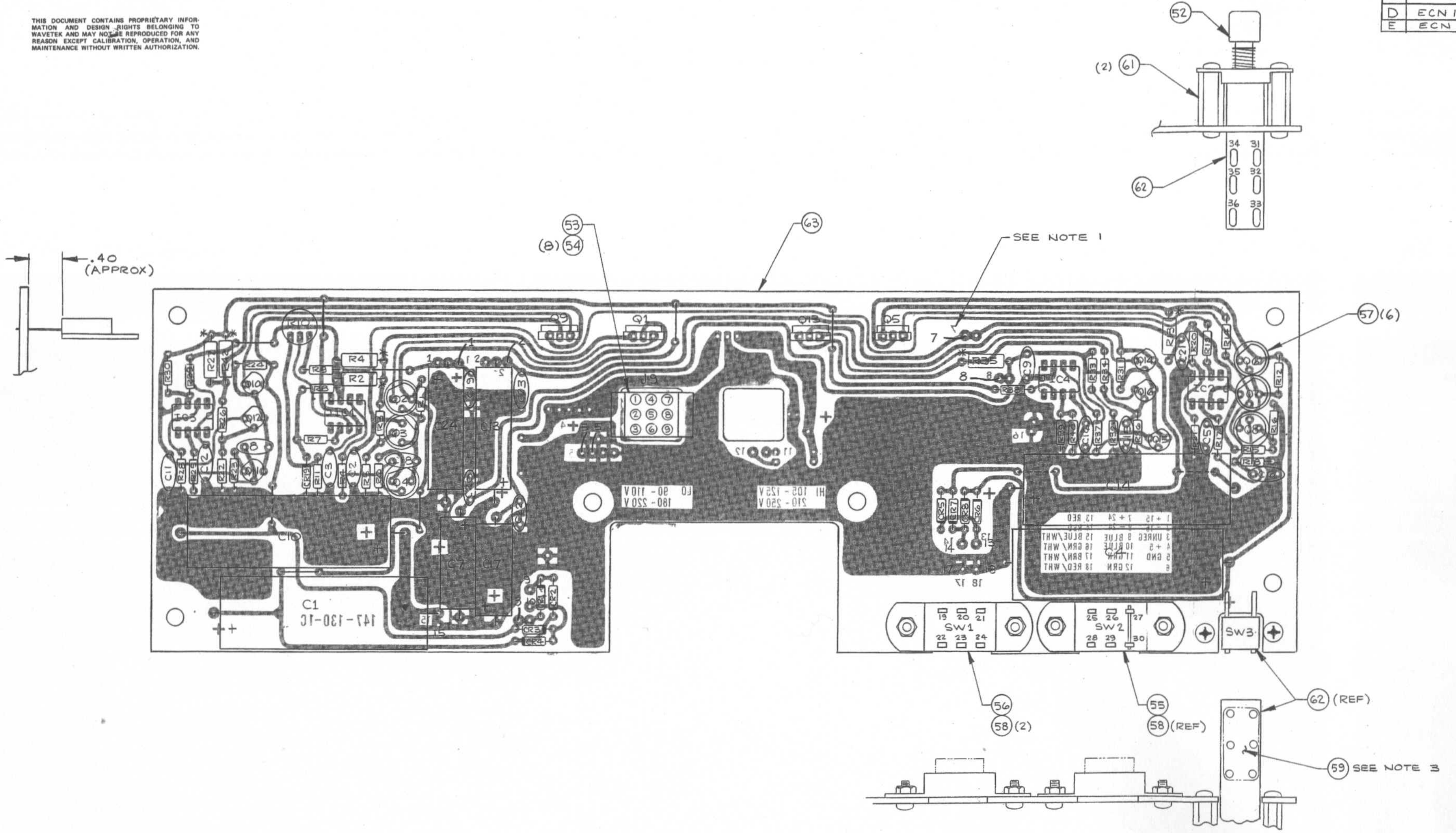
LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
1	REAR PANEL CASTING	WAVETEK	23338	D147-359	1
2					
3					
4	TRANSFORMER			A147-500	1
5	NAME PLATE			B147-370	1
6	POWER SUPPLY BD			D162-030	1
7					
8	ZIP TWIST NUT	PAL		BD-125009	4
9	U-NUT	TINNERMAN		C18050-632-4	12
10					
11	CLAMPING BAR	WAVETEK	-	A147-379	1
12	INSULATOR			B147-367	1
13					
14	COMPRESSION STRIP	WAVETEK		B162-312	1
15					
16					
17	FUSE HOLDER	LITTELFUSE	75915	345001	1
18	FUSE 1/2 AMP (115V)			313.500	1
19	FUSE 1/4 AMP (230V)			313.250	1
20	POWER CONNECTOR	SWITCHCRAFT	82389	EAC-301	1
21					
22	SOLDER LUG	H.H. SMITH	83330	1414-4	1
23	SOLDER LUG			1414-8	1

1. FOR CHASSIS WIRING SEE CHASSIS SCHEMATIC D162-200.

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN	DATE 3-1-74	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR Kwok Lo	4/10/74	TITLE ASSEMBLY, REAR. PANEL
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ±.010 ANGLES ±1 XX ±.030		
	DO NOT SCALE DWG		MODEL NO 162
	SCALE NONE		DWG NO D162-001 REV D
			CODE IDENT 23338 SHEET 1 OF 1

REV	ECN	BY	DATE	APP
D	ECN 1103	[illegible]	9-25-74	
E	ECN 1324	Ro	7-10-5	



3. APPLY SILICONE RUBBER (ITEM 59) AS REQUIRED TO THIS AREA ENCAPSULATING PROTRUDING SWITCH CONTACT PINS (THIS SIDE ONLY).
2. ✱ INDICATES RESISTORS MOUNTED OFF BOARD.
1. NUMBERS INDICATE CHASSIS WIRING SEE CHASSIS SCHEMATIC.

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN	DATE 3-21-74	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR Kwok Lo	4/1/74	TITLE ASSEMBLY, POWER SUPPLY BD
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 .XX ±.030 ANGLES ±1°		
	DO NOT SCALE DWG		MODEL NO. 162 / DWG NO. D162-030 / REV E
	SCALE		CODE IDENT 23338 / SHEET 1 OF 2

REV	ECN	BY	DATE	APP

PARTS LIST

LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
1	Capacitors				
2	Ceramic Disc 1000V 33pF	CRL	71590	DD330	2
3	Ceramic Disc 50V .01µF	CRL	71590	CK103	8
4	Ceramic Disc 20V .1µF	CRL	71590	UK20-104	6
5					
6	Electrolytic 50V 50µF	Sprague	56289	500D506G050DD7	2
7	Electrolytic 16V 250µF	Sprague	56289	22-437-250-15T	2
8	Electrolytic 50V 500µF	Sprague	56289	39D507G050GL4	2
9	Electrolytic 35V 1000µF	Sprague	56289	36-750-1000-35T	2
10					
11					
12					
13	Diode Rectifier	Semtech	14099	SCE1	8
14	Diode Zener	Wavetek	23338	A130-506	1
15					
16					
17	Integrated Circuit	Fairchild	33888	µA741TC	4
18					
19					
20					
21	Transistor 2N3642	Fairchild	33888	2N3642	6
22	Transistor 2N4248	Fairchild	33888	2N4248	6
23	Transistor TIP-29	Texas Inst.	01295	TIP-29	2
24	Transistor TIP-30	Texas Inst.	01295	TIP-30	2
25					
26					
27	Resistors				
28	Metal Film 1/8W 1% 392Ω	Corning	16299	RN55D	2
29	Metal Film 1/8W 1% 464Ω	Corning	16299	RN55D	2
30	Metal Film 1/8W 1% 681Ω	Corning	16299	RN55D	2
31	Metal Film 1/8W 1% 2.21K	Corning	16299	RN55D	4
32	Metal Film 1/8W 1% 2.74K	Corning	16299	RN55D	2
33	Metal Film 1/8W 1% 2.87K	Corning	16299	RN55D	1
34	Metal Film 1/8W 1% 3.92K	Corning	16299	RN55D	1
35	Metal Film 1/8W 1% 4.75K	Corning	16299	RN55D	7
36	Metal Film 1/8W 1% 5.76K	Corning	16299	RN55D	2
37	Metal Film 1/8W 1% 6.19K	Corning	16299	RN55D	1
38	Metal Film 1/8W 1% 8.25K	Corning	16299	RN55D	1
39	Metal Film 1/8W 1% 9.09K	Corning	16299	RN55D	2
40	Metal Film 1/8W 1% 9.53K	Corning	16299	RN55D	2
41	Metal Film 1/8W 1% 18.2K	Corning	16299	RN55D	2
42	Metal Film 1/8W 1% 38.3K	Corning	16299	RN55D	2
43					
44					
45	Carbon 1/2W 5% 3.9Ω	Stackpole	29604	RC20GF	6
46					
47	Matched Set 10K (-64)	Corning	16299	RN55D	1set
48					
49	Potentiometer 1K	Beckman	80740	91AR1K	1
50					
51					
52	Button (BLACK B-315)	CRL	71590	J52315 (BLACK)	1
53	Connector	Molex	27264	03-06-1091	1
54	Pin (Female)	Molex	27264	02-06-1103	8
55	Switch (115-230)	Switchcraft	82389	46256LF	1
56	Switch (Hi-Lo)	Switchcraft	82389	SW422-FT-HK	1
57	Transipad	Milton Press	07047	10123N	6
58	Solder Guard	Switchcraft	82389	46256LF-SG	2

PARTS LIST

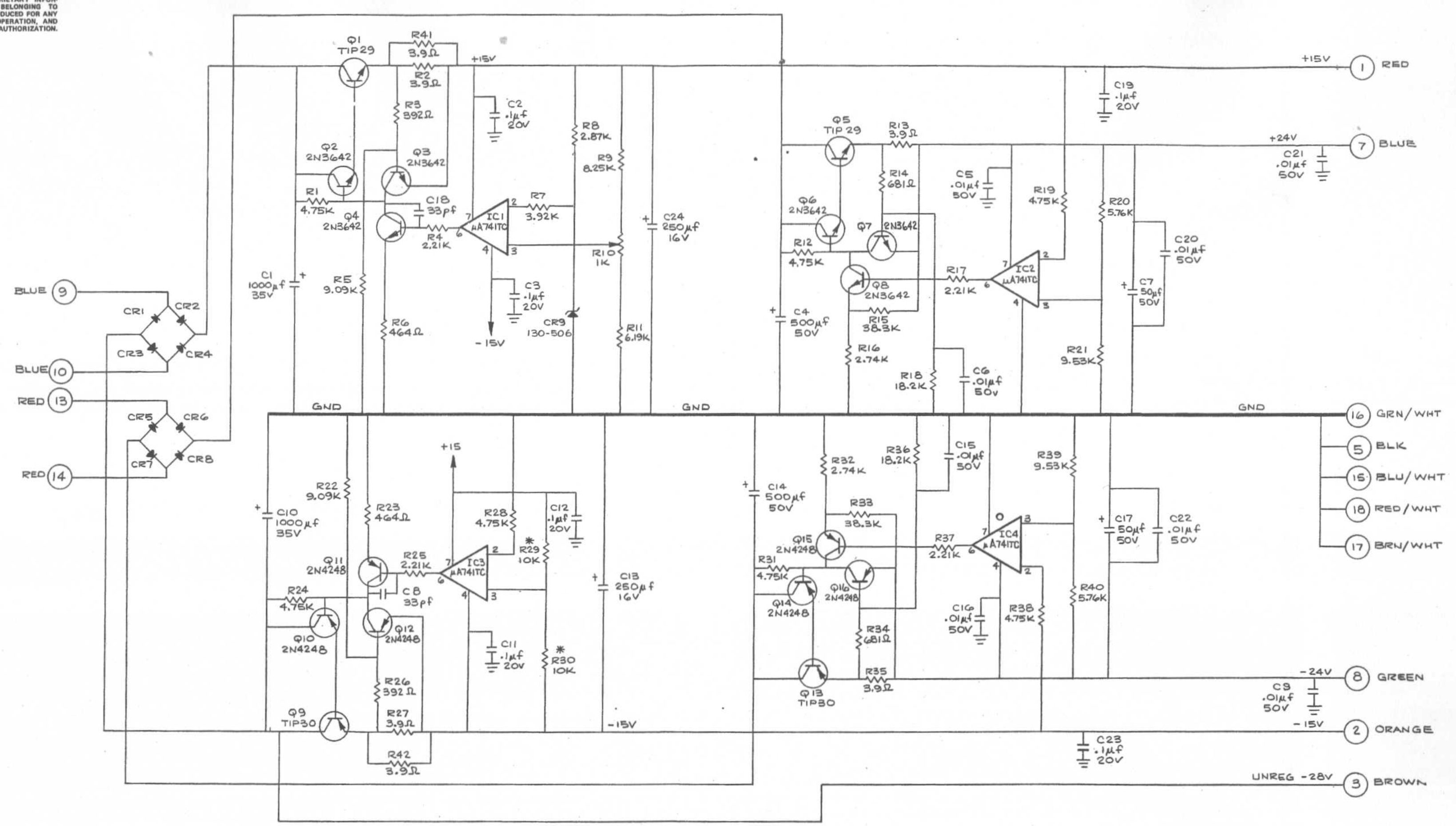
LINE NO.	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
59	Silicone Rubber	Dow Corning	71894	3140	AR
60					
61	Standoff	Wavetek	23338	013-003-1	2
62	Power Switch	Wavetek	23338	157-422	1
63	Circuit Board	Wavetek	23338	147-130C	1
64					
65					
66	Schematic	Wavetek	23338	D162-230	REF
67					
68					
69					
70					
71					
72					
73					
74					
75					
76					
77					
78					
79					
80					
81					
82					
83					
84					
85					
86					
87					

LINE ITEM REFERENCE LIST

REF DES	P/L LINE		REF DES	P/L LINE		REF DES	P/L LINE
C1	9		R1	35			
C2	4		R2	45			
C3	4		R3	28			
C4	8		R4	31			
C5	3		R5	39			
C6	3		R6	29			
C7	6		R7	34			
C8	2		R8	33			
C9	3		R9	38			
C10	9		R10	49			
C11	4		R11	37			
C12	4		R12	35			
C13	7		R13	45			
C14	8		R14	30			
C15	3		R15	42			
C16	3		R16	32			
C17	6		R17	31			
C18	2		R18	41			
C19	4		R19	35			
C20	3		R20	36			
C21	3		R21	40			
C22	3		R22	39			
C23	4		R23	29			
C24	7		R24	35			
			R25	31			
CR1	13		R26	28			
CR2	13		R27	45			
CR3	13		R28	35			
CR4	13		R29	47			
CR5	13		R30	47			
CR6	13		R31	35			
CR7	13		R32	32			
CR8	13		R33	42			
CR9	14		R34	30			
			R35	45			
IC1	17		R36	41			
IC2	17		R37	31			
IC3	17		R38	35			
IC4	17		R39	40			
			R40	36			
Q1	23		R41	45			
Q2	21		R42	45			
Q3	21						
Q4	21						
Q5	23						
Q6	21						
Q7	21						
Q8	21						
Q9	24						
Q10	22						
Q11	22						
Q12	22						
Q13	24						
Q14	22						
Q15	22						
Q16	22						

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN	DATE 2/28/7[illegible]	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR Kwok Lo	4/12/7[illegible]	TITLE ASSEMBLY, POWER SUPPLY BD
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.030		
	DO NOT SCALE DWG		MODEL NO. 162 / DWG NO. B162-030,0 / REV E
	SCALE NONE		CODE IDENT 23338 / SHEET 2 OF 2

REV	ECN	BY	DATE	APP



LAST REFERENCE DESIGNATIONS USED

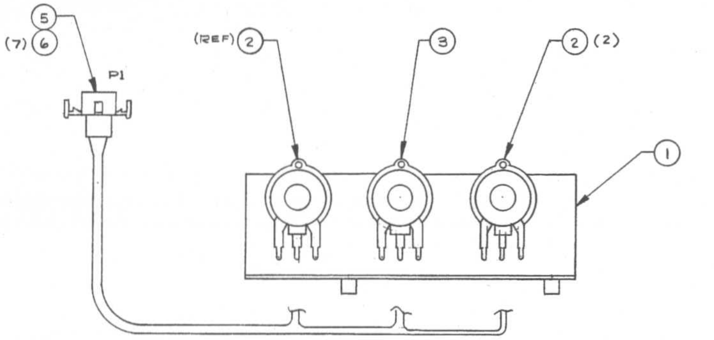
CAPACITOR	C24
DIODE	CR9
INTEGRATED CIRCUIT	IC4
TRANSISTOR	Q16
RESISTOR	R42

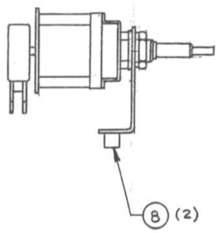
4. COLORED CALLOUTS INDICATE TRANSFORMER LEADS.
3. SEE CHASSIS SCHEMATIC D162-200 FOR INTERWIRING.
2. DIODES ARE SCE-1.
1. * INDICATES MATCHED PAIR (R29, R30).

NOTE: UNLESS OTHERWISE SPECIFIED

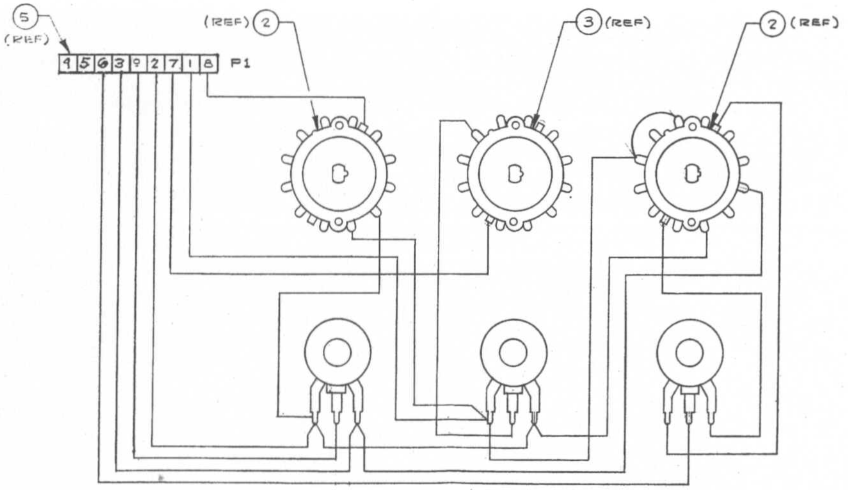
REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. Reoman DATE 1-7-74	WAVETEK SAN DIEGO • CALIFORNIA
MATERIAL	PROJ ENGR Kwok Lo 1/12/74	
	RELEASE APPROV	TITLE SCHEMATIC POWER SUPPLY BOARD
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.030	
	DO NOT SCALE DWG	MODEL NO. 162 DWG NO. D162-230 REV A
	SCALE	CODE IDENT 23338 SHEET 1 OF 1

REV	ECN	BY	DATE	APP





PARTS LIST					
ITEM	DESCRIPTION	MFGR	FSCM	MFGR P/N	QTY
1	BRACKET	WAVETEK	23338	C162-306	1
2	SWITCH ASSY			D162-024	2
3	SWITCH ASSY			D162-025	1
4					
5	CONNECTOR	MOLEX	27264	03-06-2091	1
6	PINS (MALE)	MOLEX	27264	02-06-2103	7
7					
8	STANDOFF (#6x¼LG)	USECO	88245	15308-¼-11	2



WIRING DIAGRAM

AS VIEWED FROM POTENTIOMETER END OF SWITCH ASSYS

NOTE: UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN B. REDMAN	DATE 2-4-74	WAVETEK SAN DIEGO • CALIFORNIA	
MATERIAL —//—	PROJ ENGR Kwok Lo	4/12/74	TITLE SWITCH BRACKET ASSEMBLY	
	RELEASE APPROV			
FINISH WAVETEK PROCESS —//—	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ±.010 ANGLES ±1° .XX ±.030			
	DO NOT SCALE DWG		MODEL NO. 162	DWG NO. D162-004 REV A
	SCALE FULL		CODE IDENT 23338	SHEET 1 OF 1